International English

Panasonic
Lithium Batteries
Technical Handbook 2000

PDF File Technical Handbook

NOTICE TO READERS

It is the responsibility of each user to ensure that each system is adequately designed to be safe and compatible with all conditions encountered during use and in conformance with existing standards and requirements. The circuits contained herein are illustrative only and each user must ensure that each circuit is safe and otherwise completely appropriate for the desired application.

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Matsushita Battery Industrial Co., Ltd.

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SAFETY WARNINGS AND PRECAUTIONS FOR:

- **Cylindrical type lithium batteries (BR and CR)**
- **Coin type lithium batteries (BR and CR) and Pin type lithium batteries**
- **Rechargeable coin type lithium batteries (VL,MT and ML)**

Please be sure to observe the following warnings. If misused, batteries may leak or rupture, causing injury or damage to equipment.

1. Do not charge, short, disassemble, deform or heat batteries. Do not throw batteries into fire (an exception is to pass batteries through dipping solder). Abuse as described here may cause heating, rupture, or ignition of batteries because of flammable substances contained within such as lithium and organic solvents.

2. Be sure to connect the (+) and (-) electrodes correctly.

3. Do not connect the (+) and (-) electrodes to each other with metal or wire. Do not carry or store batteries together with a metallic necklace, paperclips, etc.

4. Do not charge rechargeable batteries with a higher voltage than specified. Do not charge primary batteries.

5. Do not bring batteries into contact with metal or other batteries. This may cause batteries to heat, rupture, or ignite.

6. Avoid mixed use of batteries, i.e. new, used or different types.

7. Avoid direct soldering to batteries.

8. Keep batteries away from direct sunlight, high temperatures, and high humidity.

9. When discarding batteries, insulate the terminals by wrapping them with tape, etc.

10. Keep batteries out of reach of small children. Should a child swallow a battery, consult a physician immediately.

INTRODUCTION

The kinds of equipment that require batteries are rapidly increasing, and many use lithium batteries. To meet this demand, various lithium batteries have been developed.

The selection of batteries is an important step in the development of equipment. The features of various lithium batteries are described in this catalog as a reference for your design of equipment

Elements of Battery Quality

For batteries, especially lithium batteries, good quality is exemplified by excellence in the following characteristics:

- **Leakage resistance**

Batteries should be free from leakage of liquids, which can damage equipment and spoil the contact at terminals, making the operation of equipment unstable.

- **Storage characteristics**

During long-term storage, battery capacity gradually diminishes due to self-discharging. The less capacity lost, the higher the quality of the batteries.

- **Discharge characteristics**

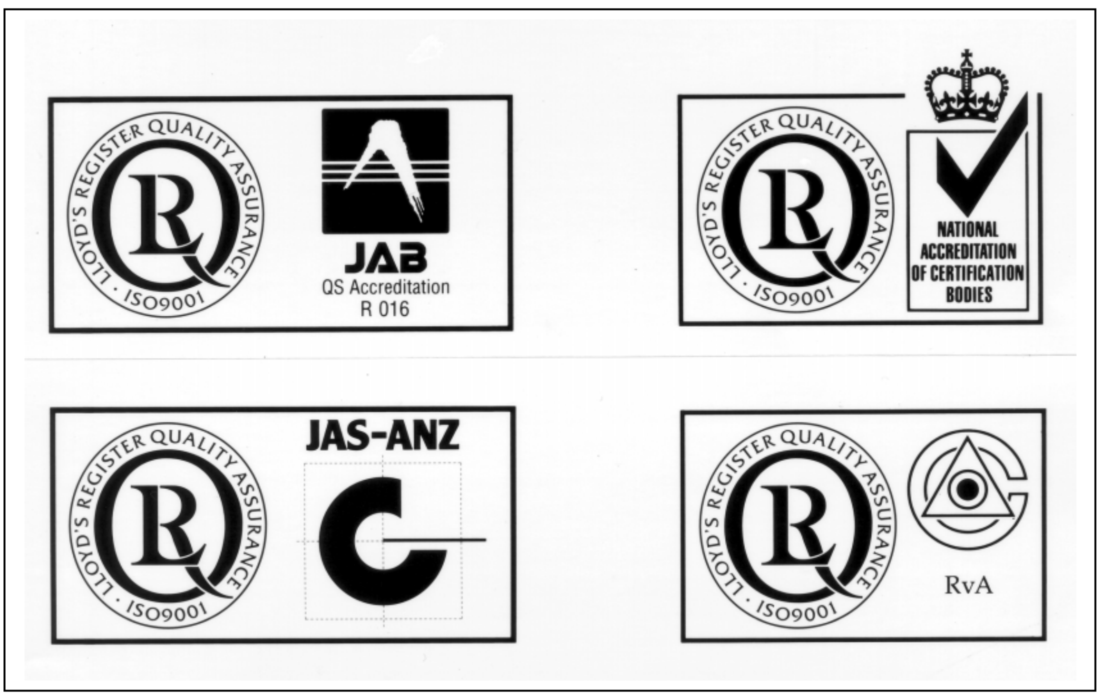
Whereas it is desirable that more energy can be drawn from a battery of limited capacity, it remains essential for the battery to satisfy electrical characteristics such as the voltage and current required by the equipment.

- **Temperature characteristics**

The performance of a battery generally varies with temperature. The less the variation, the better the battery.

- **Reliability**

While batteries should meet various requirements, it is also important that they have the same performance, based on uniform quality, at all times, regardless of where or when they are purchased. A battery of high reliability is a battery of high quality and is not likely to fail.



LITHIUM BATTERIES

Overview

Since 1971, when we began developing and mass-producing lithium batteries, Panasonic has offered them in various shapes (cylindrical type, coin type and pin type) and various sizes.

Today, lithium batteries can be found in many new applications where conventional batteries are not applicable. Lithium batteries are meeting diverse needs in the electronics field: high-current discharge fields found in 35mm cameras, ultralow-current discharge fields found in electronic watches, and IC memory backup power supplies which require long-term reliability.

Panasonic has a continuing program of meticulous testing for the stability of the batteries in various environmental conditions. This testing is conducted over a long period of time, providing proven data of changes which cannot be obtained by acceleration tests in a short period. As a result, the company has earned UL recognition, the U.S. safety standard.

TYPES AND FEATURES OF LITHIUM BATTERIES

Panasonic currently manufactures and markets the battery types listed below.

		Lithium Series					Zinc Series		
Battery Type	Name of battery	Poly carbon-monofluoride lithium batteries	Manganese dioxide lithium batteries	Vanadium pentoxide lithium batteries	Manganese titanium lithium rechargeable batteries	Manganese lithium rechargeable batteries	Silver oxide batteries	Alkaline button batteries	Zinc air batteries
	Symbol	BR	CR	VL	MT	ML	SR	LR	PR
Type	Cylindrical type	•	•						
	Coin type	•	•	•	•	•			•
	Button type						•	•	•
	Pin type	•							
System	Cathode	(CF)n	MnO_2	$V_2 0_5$	LixMnOy	LixMnOy	Ag_2O	MnO_2	0_2
	Anode	Li	Li	LiA1	LixTiOy	LiA1	Zn	Zn	Zn
	Electrolyte (solvent)	Lithium salt (organic solvent)	Lithium salt (organic solvent)	Lithium salt (organic solvent)	Lithium salt (organic solvent)	Lithium salt (organic solvent)	KOH or NaOH (ZnO added) (water)	KOH or NaOH (ZnO added) (water)	KOH (ZnO added) (water)
Nominal voltage(V)		3V	3V	3V	1.5V	3V	1.55V	1.5V	1.4V
Energy density	mWh/g	250-480	200-400	15-50	5-15	75-110	75-110	50-70	210-430
	mWh/cc	440-480	400-600	60-130	25-40	85-100	300-350	150-250	770-1000
Storability		⊗	⊗	⊗	⊗	⊗	o	o	⊗ *1
Discharge characteristic	Voltage stability	o	o	o	o	o	⊗		⊗
	Low-current discharge	⊗	⊗	⊗	⊗	⊗	o	o	

(Note) ⊗ : Excellent
o : Good

*1 : Sealed with seal intact

APPLICATION GUIDE

Application		Current Consumption	Type of Battery													
			Button Type			Coin Type					Cylindrical Type					Solar battery
		100nA, 1µA, 10µA, 100µA, 1mA, 10mA, 100mA, 1A	Silver oxide battery	Alkaline button battery	Zinc Air battery	Manganese dioxide lithium battery	Poly carbon-monofluoride lithium battery	Vanadium Pentoxide Lithium Rechargeable battery	Manganese Titanium Lithium Rechargeable battery	Manganese Lithium Rechargeable battery	Manganese battery	Alkaline battery	Poly carbon-monofluoride lithium battery	Manganese dioxide lithium battery	Nickel cadmium battery	
Watches	Analog		⊗				o		⊗ *							o
	Digital		⊗			o	⊗		⊗ *							o
	Pen		⊗	o												
	Clock		o	⊗		o					⊗	o			o	o
Desktop calculators	Single-function		o	⊗		⊗	o				o	o			o	⊗
	Multiple-function		⊗	⊗		o	⊗				o	o			o	
	With Printer										o	o			⊗	
Cameras	AE cameras		o	⊗		o	⊗				o	o	o	⊗		o
	Motor-driven										o	⊗			o	
	With built-in Strobescope										o	⊗	o	⊗	o	
Hearing Aids	Box type										⊗	o			o	
	Ear-fit type		o		⊗											
Electronic toys			o	⊗							o	o			o	o
Pagers					o						⊗				o	
Portable radios			o	o		o					⊗	o			o	o
Greeting cards			o	⊗		o	o									
Electronic lighters			o	⊗												
IC cards							o									
Memory backup						o	⊗	⊗	⊗	⊗			⊗	⊗	⊗	
Medical equipment			⊗				o						o	o		
Electronic clinical thermometers			⊗	o		o										

REMARKS: ⊗ = Most recommended
o = Acceptable
* = Rechargeable watches

SIZE AND MODEL NUMBER (COIN TYPE)

Diameter mm / Height mm	30		24.5		23		20		16		12.5		10		9.5		6.8		5.8	
	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)	Model No.	Capacity (mAh)
7.7			CR2477 BR2477A	1000 1000																
5.4					CR2354	560														
3.2	BR3032 CR3032 VL3032	500 500 100					BR2032 *CR2032	190 220	BR1632 CR1632 BR1632A	120 125 120										
3.0					BR2330 BR2330A *CR2330 VL2330	255 255 265 50														
2.7																				
2.5					BR2325	165	*CR2025	165			BR1225 Δ BR1225A	48 48	*CR1025	30						
2.1																	VL621 MT621 ML621 ML621S	1.5 1.5 3 4.5		
2.0					BR2320 *CR2320 VL2320	110 130 30	BR2020 VL2020 ML2020	100 20 45	CR1620 MT1620	75 14	BR1220 *CR1220 VL1220	35 35 7			MT920	4				
1.6							BR2016 *CR2016	75 90	BR1616 *CR1616	48 55	BR1216 *CR1216 VL1216	25 25 5					ML616 ML616S MT616	2 2.9 1.05	MT516	0.9
1.2			CR2412	100			*CR2012	55	CR1612	40	Δ CR1212	18					ML612S	2.3		

Notes: * marked items are specified by JIS
Underlined items are rechargeable batteries.
Δ marked items are under development.
The type code comprises two alphabetic capital letters and three or more figures as exemplified below:
Example:

B — Battery type
R — Round shape
2 3 — Diameter
2 5 — Height

Height — Figures to first decimal place, omitting the decimal point
Diameter — Integers omitting fractions
Battery type, Round shape — In accordance with JIS and IEC standards

The above-described expression is supported by the Japan International Standard Committee of Clocks and Watches and is also an established practice in Japan.

Poly carbonmonofluoride (BR series) lithium batteries (spiral type)

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal*1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR-2/3A	---	---	3	1200	2.5	17.0	33.5	13.5
BR-2/3AH **2	---	---	3	1350	2.5	17.0	33.5	13.5
BR-2/3AG **2	---	---	3	1450	2.5	17.0	33.5	13.5
BR-A	---	---	3	1800	2.5	17.0	45.5	18.0
BR-AH**2	---	---	3	2000	2.5	17.0	45.5	18.0
BR-AG**2	---	---	3	2200	2.5	17.0	45.5	18.0
BR-C	---	---	3	5000	150	26.0	50.5	42.0

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* *2 H or G indicate higher capacity versions.

Manganese dioxide (CR series) lithium batteries (spiral type) (User replaceable packs)

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
CR-2	---	---	3	750	20	15.6	27.0	11.0
CR123A	---	CR17345	3	1300	20	17.0	34.5	17.0
2CR5	---	2CR5	6	1300	20	34.0 *2	45.0	38.0
CR-P2	---	CR-P2	6	1300	20	35.0 *2	36.0	37.0

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C …CR2/CR123A
Nominal capacity shown above is based on standard drain and cut off voltage down to 4.0 V at 20°C …2CR5/CR-P2
* 2 Width

COIN TYPE LITHIUM BATTERIES

Poly carbonmonofluoride (BR series) lithium batteries

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR1216	---	---	3	25	0.03	12.5	1.60	0.6
BR1220	---	---	3	35	0.03	12.5	2.00	0.7
BR1225	---	BR1225	3	48	0.03	12.5	2.50	0.8
BR1616	---	---	3	48	0.03	16.0	1.60	1.0
BR1632	---	---	3	120	0.03	16.0	3.20	1.5
BR2016	---	BR2016	3	75	0.03	20.0	1.60	1.5
BR2020	---	BR2020	3	100	0.03	20.0	2.00	2.0
BR2032	---	---	3	190	0.03	20.0	3.20	2.5
BR2320	---	BR2320	3	110	0.03	23.0	2.00	2.5
BR2325	---	BR2325	3	165	0.03	23.0	2.50	3.2
BR2330	---	---	3	255	0.03	23.0	3.00	3.2
BR3032	---	BR3032	3	500	0.03	30.0	3.20	5.5

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C

Manganese dioxide (CR series) lithium batteries

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
CR1025	CR1025	CR1025	3	30	0.10	10.0	2.50	0.7
CR1212 *2	---	---	3	18	0.10	12.5	1.20	0.5
CR1216	CR1216	CR1216	3	25	0.10	12.5	1.60	0.7
CR1220	CR1220	CR1220	3	35	0.10	12.5	2.00	1.2
CR1612	---	---	3	40	0.10	16.0	1.20	0.8
CR1616	CR1616	CR1616	3	55	0.10	16.0	1.60	1.2
CR1620	---	CR1620	3	75	0.10	16.0	2.00	1.3
CR1632	---	---	3	125	0.10	16.0	3.20	1.8
CR2012	CR2012	CR2012	3	55	0.10	20.0	1.20	1.4
CR2016	CR2016	CR2016	3	90	0.10	20.0	1.60	1.6
CR2025	CR2025	CR2025	3	165	0.20	20.0	2.50	2.5
CR2032	CR2032	CR2032	3	220	0.20	20.0	3.20	3.1
CR2320	CR2320	CR2320	3	130	0.20	23.0	2.00	3.0
CR2330	CR2330	CR2330	3	265	0.20	23.0	3.00	4.0
CR2354	---	CR2354	3	560	0.20	23.0	5.40	5.9
CR2412	---	---	3	100	0.20	24.5	1.20	2.0
CR2477	---	---	3	1000	0.20	24.5	7.70	10.5
CR3032	---	CR3032	3	500	0.20	30.0	3.20	7.1

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* 2 Under Development

Poly carbonmonofluoride (BR series) lithium batteries for high temperature usage

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR1225A *2	---	---	3	48	0.03	12.5	2.50	0.8
BR1632A	---	---	3	120	0.03	16.0	3.20	1.5
BR2330A	---	---	3	255	0.03	23.0	3.00	3.2
BR2477A	---	---	3	1000	0.03	24.5	7.70	8.0

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* 2 Under Development

PIN TYPE LITHIUM BATTERIES

Poly carbonmonofluoride (BR series) lithium batteries

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR425	---	---	3	25	0.5	4.2	25.9	0.55
BR435	---	---	3	50	1	4.2	35.9	0.85

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C

Rechargeable coin type lithium batteries

Vanadium Pentoxide lithium rechargeable batteries (VL series)

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
VL621	---	---	3	1.5	0.01	6.8	2.1	0.3
VL1216	---	---	3	5	0.03	12.5	1.6	0.7
VL1220	---	---	3	7	0.03	12.5	2.0	0.8
VL2020	---	---	3	20	0.07	20.0	2.0	2.2
VL2320	---	---	3	30	0.10	23.0	2.0	2.8
VL2330	---	---	3	50	0.10	23.0	3.0	3.7
VL3032	---	---	3	100	0.20	30.0	3.2	6.3

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.5 V at 20°C

Manganese Titanium lithium rechargeable batteries (MT series)

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
MT516	---	---	1.5	0.9	0.1	5.8	1.6	0.15
MT616	---	---	1.5	1.05	0.1	6.8	1.6	0.2
MT621	---	---	1.5	1.5	0.1	6.8	2.1	0.3
MT920	---	---	1.5	4.0	0.2	9.5	2.0	0.5
MT1620	---	---	1.5	14.0	0.5	16.0	2.0	1.3

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 1.0 V at 20°C

Manganese Lithium rechargeable batteries (ML series)

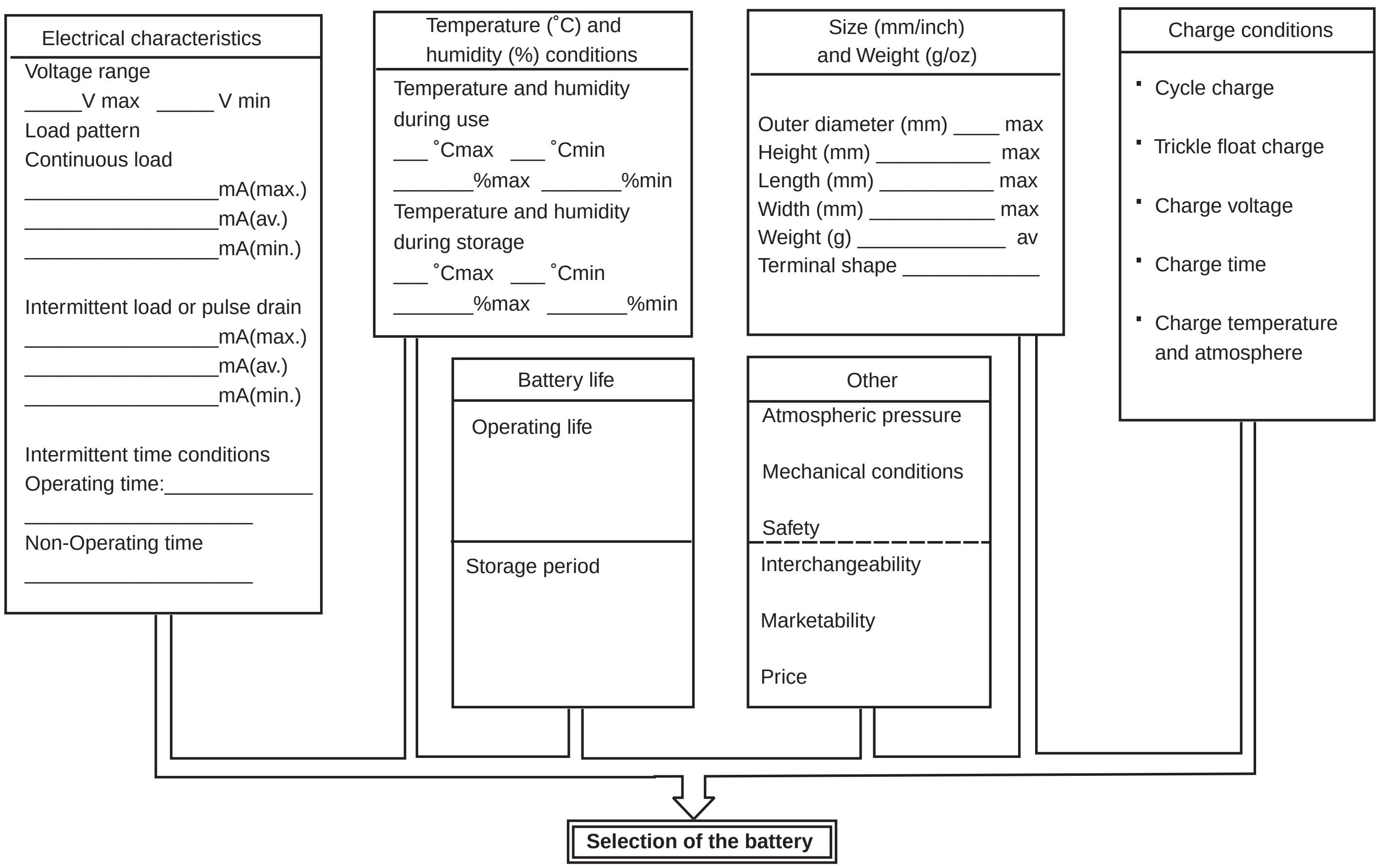
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
ML612S	---	---	3	2.3	0.01	6.8	1.2	0.15
ML616	---	---	3	2	0.01	6.8	1.6	0.2
ML616S	---	---	3	2.9	0.01	6.8	1.6	0.19
ML621	---	---	3	3	0.01	6.8	2.1	0.25
ML621S	---	---	3	4.5	0.01	6.8	2.1	0.23
ML2020	---	---	3	45	0.1	20.0	2.0	2.2

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C

SELECTING A BATTERY

The steps for selecting the proper battery for the power supply of specific equipment are summarized below.

- **Preparation of required specifications (draft)**
  The specifications (draft) are determined by checking the requirements for the battery from a list of characteristics. Technical requirements for battery selection are shown in the table below for reference.
- **Selection of a battery**
  Select several candidate batteries by referring to the catalogs and data sheets of batteries which are currently manufactured and marketed. From these, select a battery which will best meet the ideal level of the requirements. In actual practice, however, a "perfect" battery can seldom be located; therefore, the possibility of easing or partially easing the required specifications (draft) should be considered first; then a reliable battery which will meet the revised requirements should be selected.
  Such a procedure enables the economical selection of batteries. Questions during the specifying stage should be directed to our battery engineers; sometimes an appropriate battery not shown in the catalog has become available through recent development or improvement. As a rule, the specification requirements are finalized at this point.
- **Requests for developing or improving batteries**
  If no battery meeting essential and specific requirements can be found through the above-described selection process, a request for developing or improving the battery should be made to our Battery Department. Such a request should be coordinated as early as possible to allow for a sufficient development period. While this period depends on the request and its difficulty, 6 to 12 months, or more, are usually required.



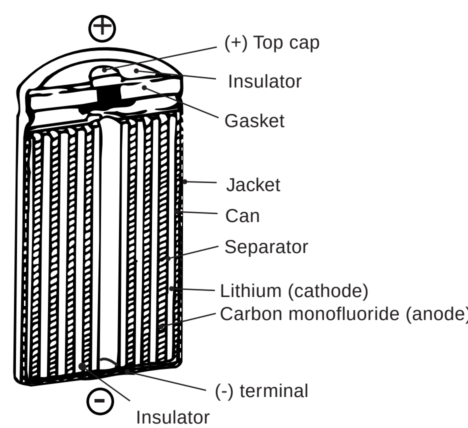
Poly carbonmonofluoride (BR series) lithium batteries (spiral type)

Overview

Since its introduction in 1973, our cylindrical type Poly carbonmonofluoride lithium battery BR-2/3A has marked a new epoch as the power supply for cameras due to its outstanding characteristics such as higher voltage and wider range of operating temperature than that of conventional dry batteries. A large number of these lithium batteries are also used in various meters, such as gas meters and in power supplies. Like BR-2/3A, BR-C and BR-A also exhibit the common advantages of the poly carbonmonofluoride lithium battery. Their features make them a battery of choice for the recent rapidly expanding IC memory backup applications, as well as in applications requiring long service periods, extending beyond 10 years.

Structure

The cylindrical type Poly carbonmonofluoride lithium batteries employ spiral-structured grids that enlarge the facing area of the positive and negative electrodes, allowing a current as large as several amperes to be drawn.



Cross sectional view of the cylindrical type BR-series lithium battery (spiral type)

Features

- **Voltage about twice that of conventional batteries**
  The nominal voltage is 3 V, approximately twice that of manganese and alkaline button batteries: a single battery can replace two or three conventional batteries.

CYLINDRICAL TYPE LITHIUM BATTERIES – CONTINUED

- **Excellent storability with minimal deterioration**
  Minimal deterioration is not necessarily an inherent feature of the lithium battery. It is achieved by adopting chemically stable materials and by superior production methodologies and sealing techniques. Panasonic cylindrical type Poly carbonmonofluoride lithium batteries show an annual deterioration rate as low as about 0.5% at room temperature, meeting the requirement for room-temperature storage periods of more than 10 years.
- **Wide operating temperature range (-40°C to 85°C)**
  Organic solvents are used for the electrolyte in lithium batteries. Therefore, the solidifying point of this electrolyte is much lower than that of the aqueous solution type electrolyte of manganese batteries, etc., enabling the use of lithium batteries in low-temperature regions. Panasonic cylindrical type poly carbonmonofluoride lithium batteries are operable over the temperature range from - 40°C to 85°C.
- **Strong leakage resistance**
  The organic electrolyte liquid used in lithium batteries shows minimal creeping. This feature and our unique sealing technique give our lithium batteries very strong leak resistance.
- **Light weight**
  The use of metal lithium as the negative-electrode active material makes lithium batteries lighter than dry batteries of the same volume.
- **Designed for safety**
  Lithium batteries employ an explosion-proof seal structure which allows for the controlled release of pressure should it increase due to an external shorting, etc.

Applications

- IC memory backup power supplies
- Camera power supplies
- Equipment for use in the polar regions, highlands, and low-temperature regions
- Water meters, gas meters, and power meters
- Rescue and emergency equipment
- Communication equipment, measurement instruments, and weather observation equipment, etc.

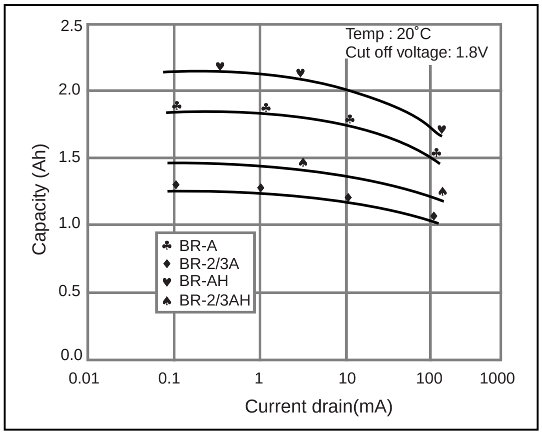
Specification Table

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal [*1] capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR-2/3A	---	---	3	1200	2.5	17.0	33.5	13.5
BR-2/3AH [**2]	---	---	3	1350	2.5	17.0	33.5	13.5
BR-2/3AG [**2]	---	---	3	1450	2.5	17.0	33.5	13.5
BR-A	---	---	3	1800	2.5	17.0	45.5	18.0
BR-AH [**2]	---	---	3	2000	2.5	17.0	45.5	18.0
BR-AG [**2]	---	---	3	2200	2.5	17.0	45.5	18.0
BR-C	---	---	3	5000	150	26.0	50.5	42.0

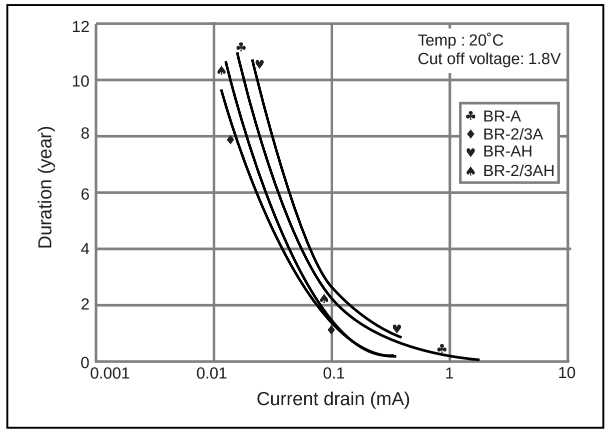
* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* * Higher capacity types are available

Characteristics

Load characteristics of the cylindrical type lithium battery

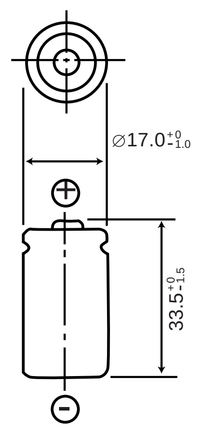


Duration vs. Current drain

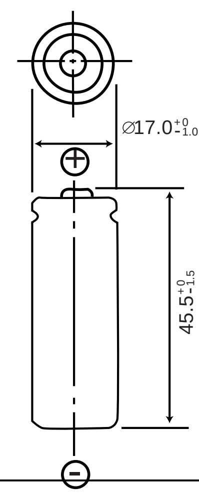


Dimensions / mm

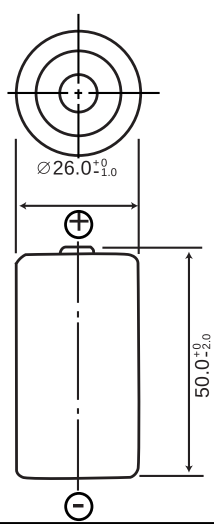
BR-2/3A, BR2/3AH, BR-2/3AG



BR-A, BR-AH, BR-AG

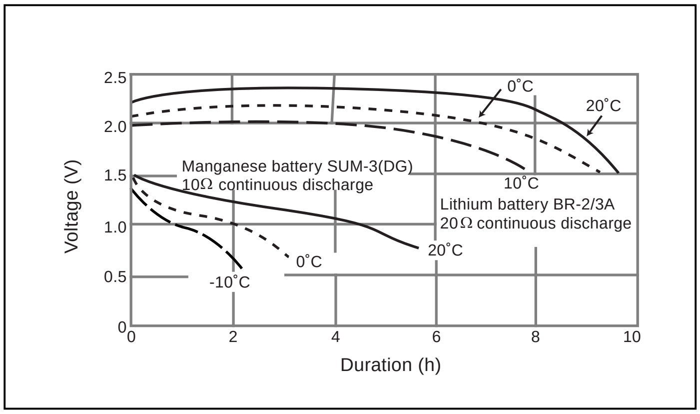


BR-C

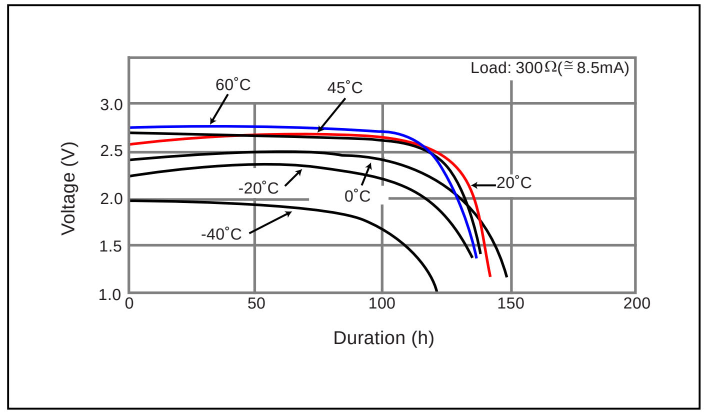


BR-2/3A

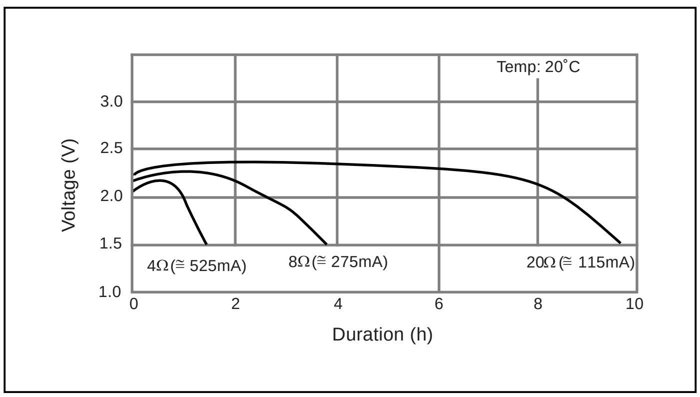
Discharge characteristics compared to a manganese battery



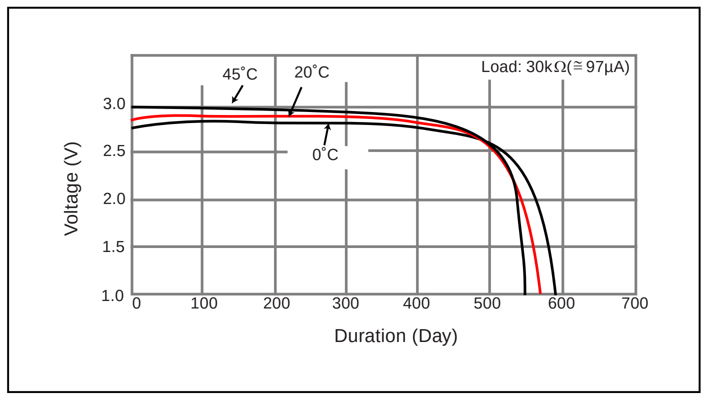
Temperature Characteristics



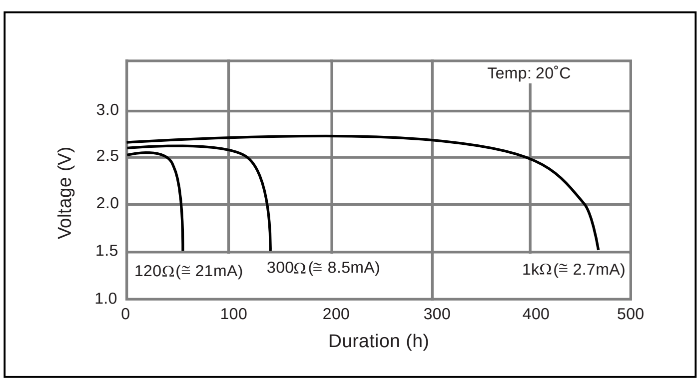
Load characteristics



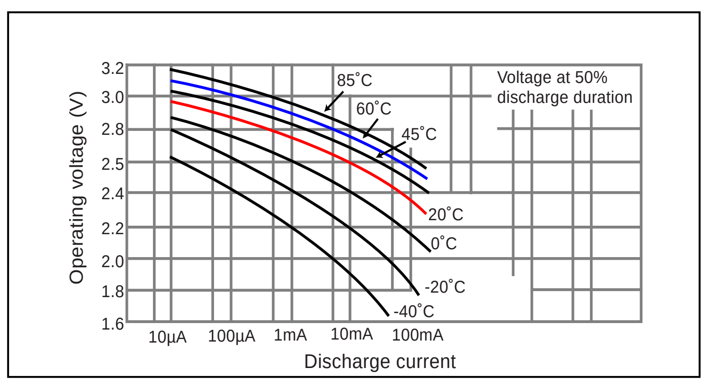
Long-period discharge characteristics



Load characteristics

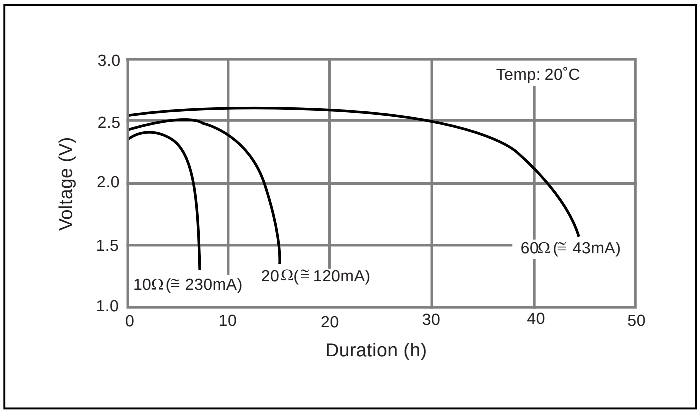


Operating voltage vs. Discharge current

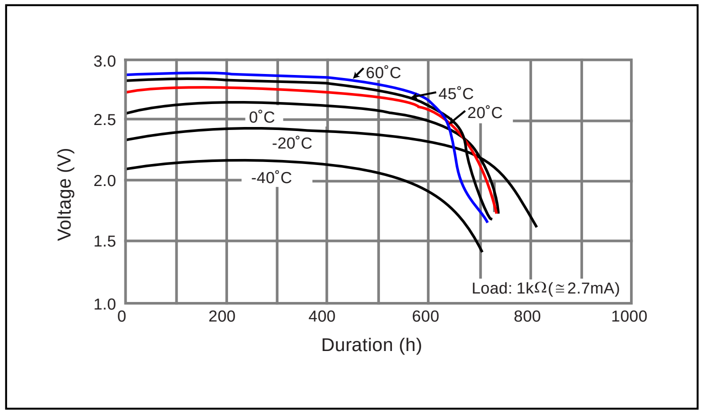


BR-A

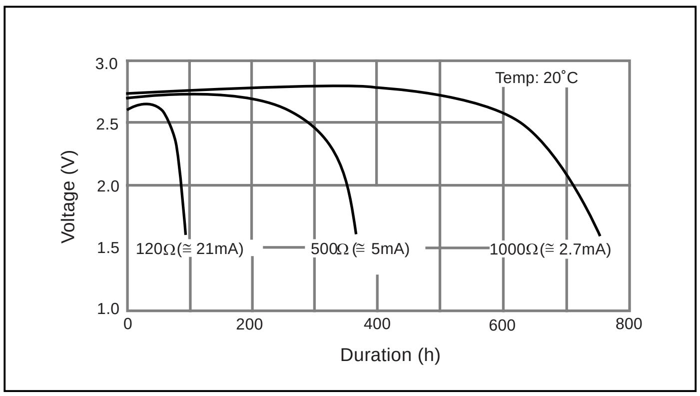
Load characteristics



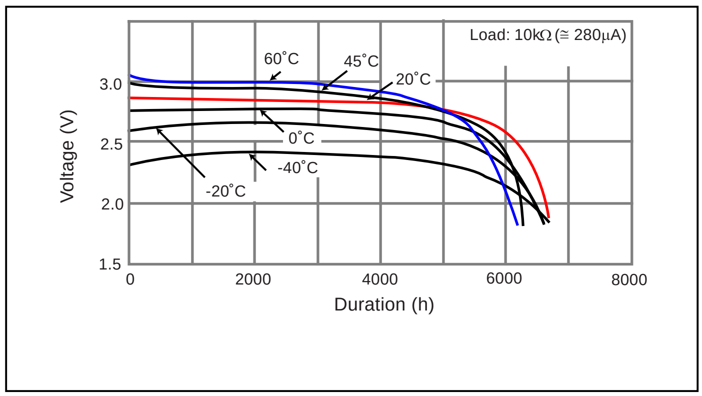
Temperature Characteristics



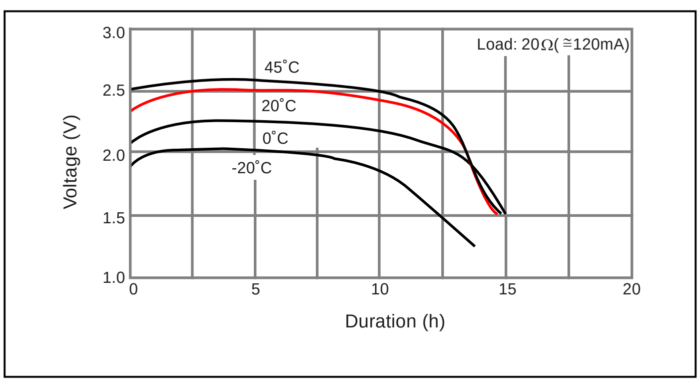
Load characteristics



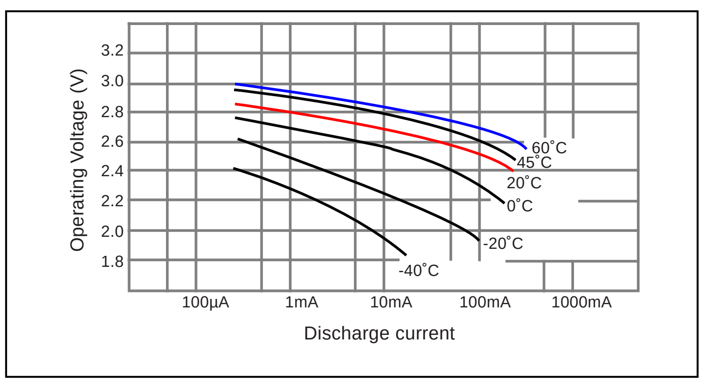
Long-period discharge characteristics



Temperature Characteristics

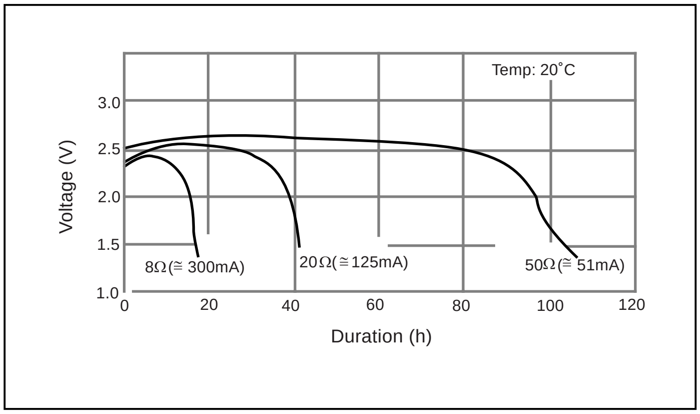


Operating voltage vs. Discharge current

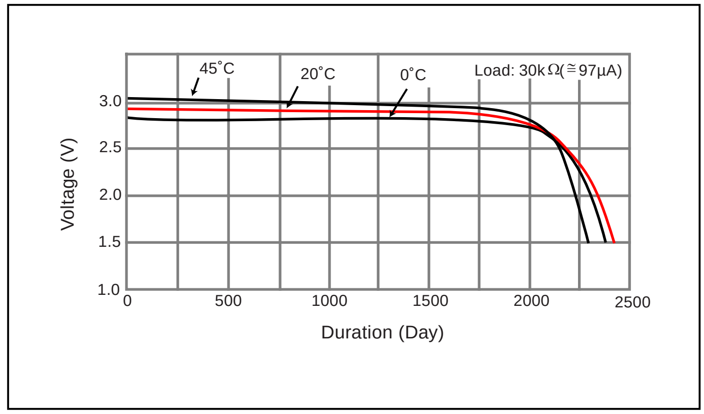


BR-C

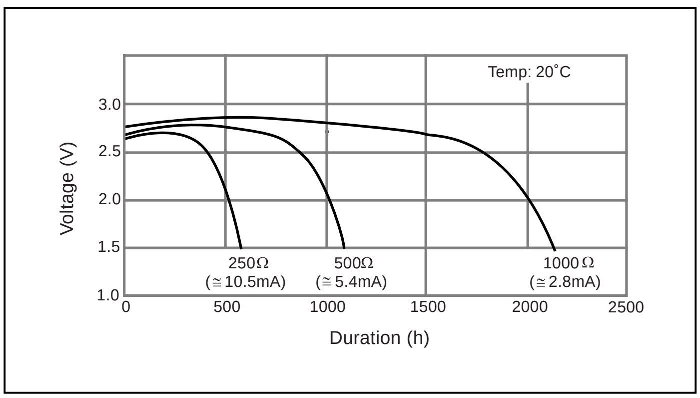
Load characteristics



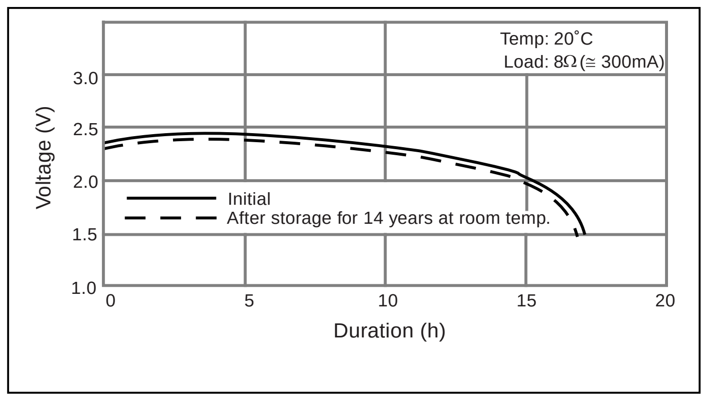
Long-period discharge characteristics



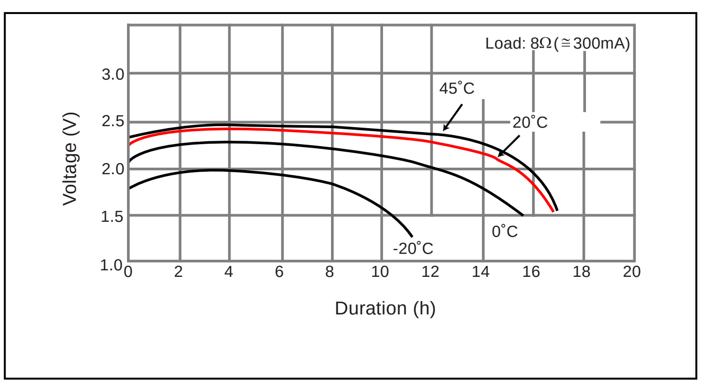
Load characteristics



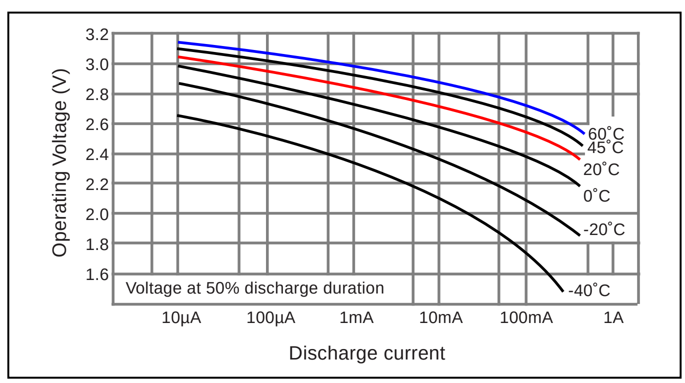
Storage characteristics



Temperature Characteristics



Operating voltage vs. Discharge current

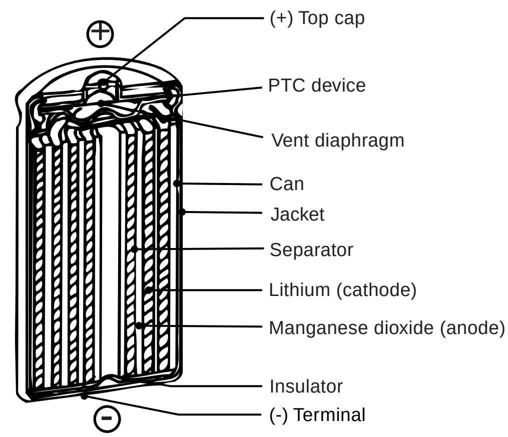


Overview

The lithium pack battery, which Panasonic was first to develop, is packaged in a resin case enabling easy replacement by users. Panasonic lithium batteries are qualified by more than 20 years of experience in production and marketing. More than 300 million of our batteries have been used in camera power supplies. The outstanding properties of Panasonic batteries are known worldwide. Panasonic meets diversified market needs with the resin package types CR-P2 and 2CR5, the single cell type CRl23A, and another single cell type CR2, newly developed in 1994.

Structure

Each of the cylindrical type manganese dioxide lithium batteries (CR2, CRl23A, 2CR5, and CR-P2) employs spiral-structured electrodes to enlarge the facing area of the positive and negative electrodes, allowing a current as large as several amperes to be drawn.



Cross sectional view of the cylindrical type CR-series lithium battery (spiral type)

MANGANESE DIOXIDE (CR SERIES) LITHIUM BATTERIES (SPIRAL)-CONTINUED

Features

- **Voltage per single cell approximately twice that of conventional batteries**
  The rated voltage of the single cell type (CR2 and CR123A) is 3V, approximately twice that of dry batteries. With the pack type, the rated voltage is 6V, enabling high-speed charging for cameras and strobes.

- **Designed for safety**
  Both the single cell type (CR2 and CR123A) and pack type batteries have a built-in element (PTC element) for protecting batteries from external shorting. They are also provided with an burst-proof seal structure which allows the safe release of the battery inner pressure.

- **Excellent storability with minimal deterioration**
  Minimal deterioration is not necessarily an inherent feature of lithium batteries. It is achieved by using chemically stable materials and through superior production methodologies and sealing techniques. Panasonic cylindrical manganese dioxide lithium batteries show an annual deterioration rate as low as about 1.0% at room temperature, meeting the requirement for a room-temperature storage period of more than 10 years.

- **Wide operational temperature range (-40°C to 70°C)**
  Organic solvents are used for the electrolyte in lithium batteries. Therefore, the solidifying point of this electrolyte is much lower than that of the aqueous solution type electrolyte in manganese batteries, etc., enabling the use of lithium batteries in low-temperature regions. Panasonic cylindrical type manganese dioxide lithium batteries (spiral type) are operable over a temperature range from -40°C to 70°C.

- **Strong leakage resistance**
  The organic electrolyte liquid used in the lithium batteries shows minimal creep. This feature, and our unique sealing technique, give our lithium batteries very strong leakage resistance.

- **Light weight**
  The use of metal lithium as the anode active material makes lithium batteries lighter than dry batteries of the same volume.

Applications

- **Cameras, strobescopes, shavers, electric toothbrushes, lights, toys, etc.**

When using the batteries for other purposes than cameras or using two or more batteries together, please consult our service staff in advance.

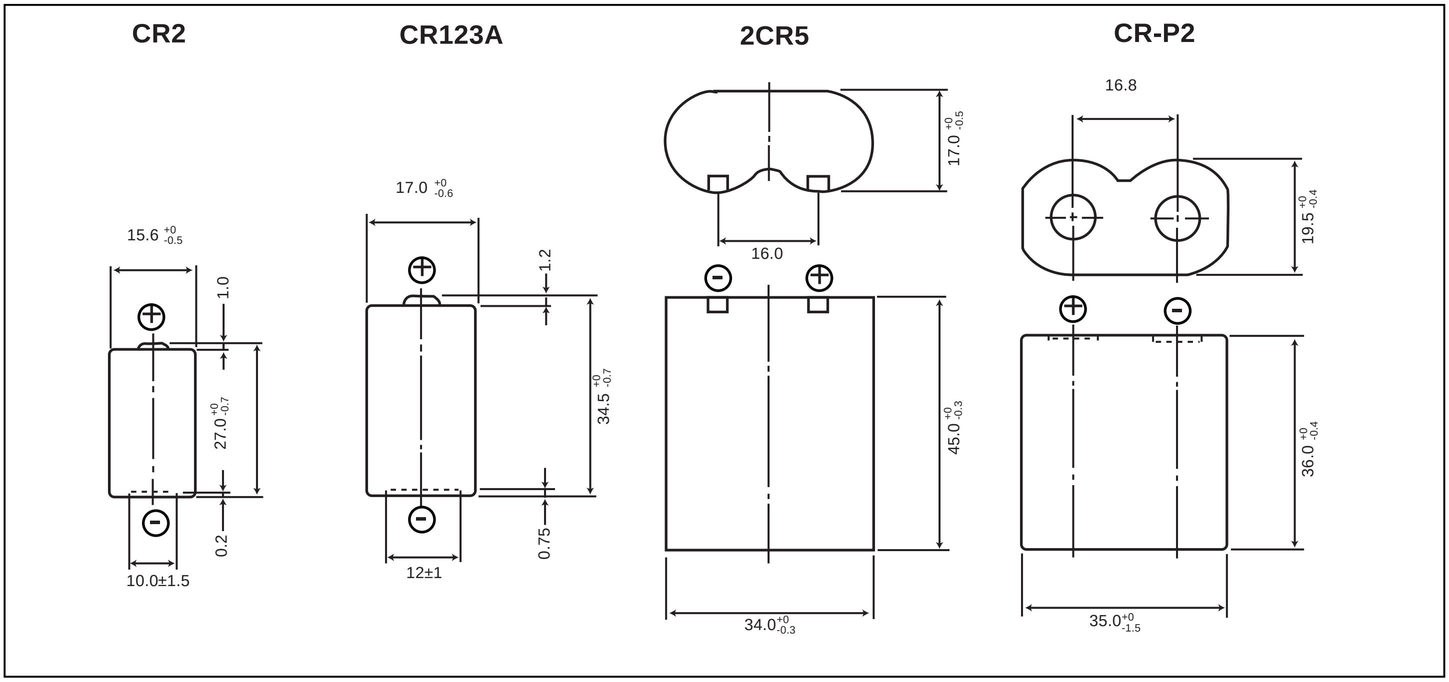
Specification Table

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
CR2	---	---	3	750	20	15.6	27.0	11.0
CR123A	---	CR17345	3	1300	20	17.0	34.5	17.0
2CR5	---	2CR5	6	1300	20	34.0 *2	45.0	38.0
CR-P2	---	CR-P2	6	1300	20	35.0 *2	36.0	37.0

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C …CR2/CR123A
Nominal capacity shown above is based on standard drain and cut off voltage down to 4.0 V at 20°C …2CR5/CR-P2
* 2 Width

Panasonic	Kodak	Energizer	Duracell	Rayovac	Varta
CR2	KCR2	EL1CR2	DLCR2	CR2R	CR2
CR123A	K123LA	EL123AP	DL123A	CR123R	CR123A
2CR5	KL2CR5	EL2CR5	DL245	2CR5R	2CR5
CR-P2	K223LA	EL233AP	DL223A	CR-P2R	CR-P2

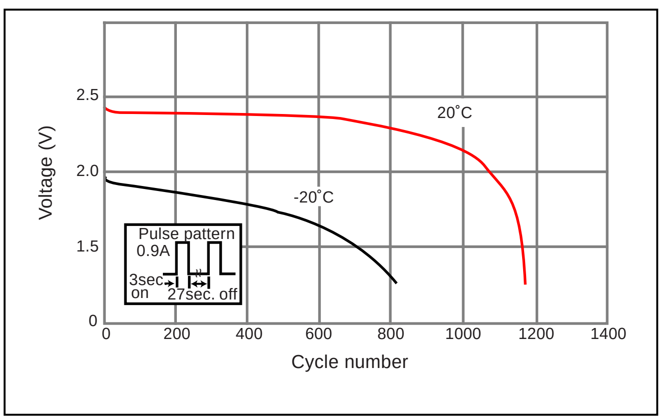
Dimensions (mm)



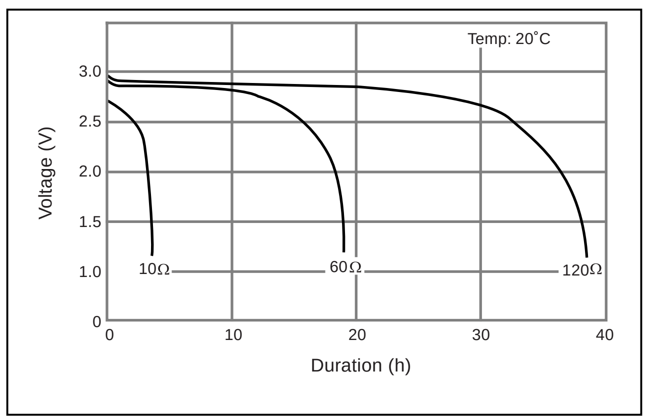
Individual Data Sheets

- **CR2**

Pulse discharge characteristics

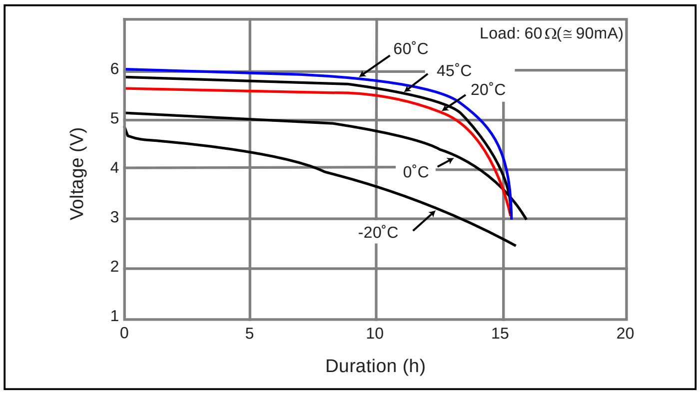


Load characteristics

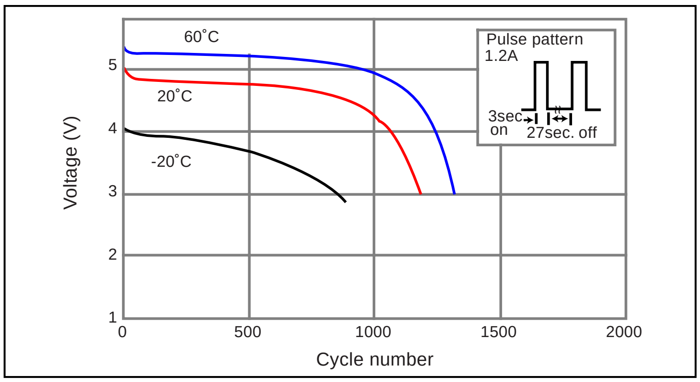


2CR5, CR-P2 (Resin package)

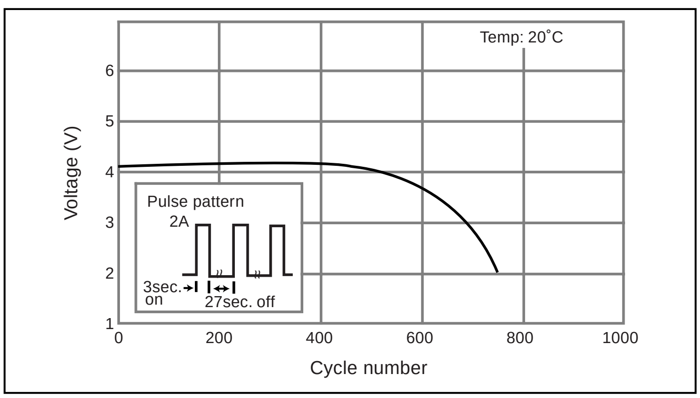
Temperature Characteristics



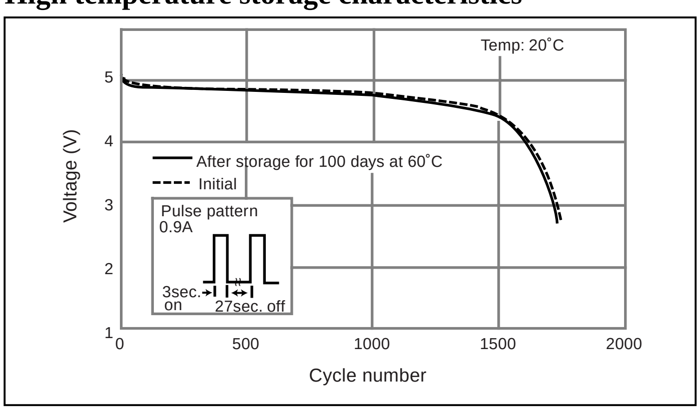
Pulse discharge characteristics



Pulse discharge characteristics

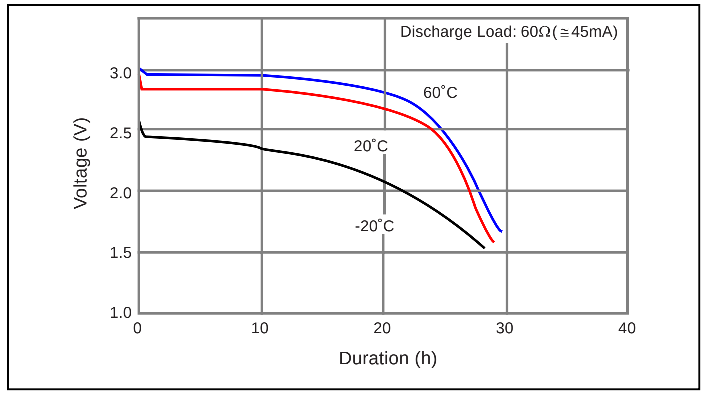


High temperature storage characteristics

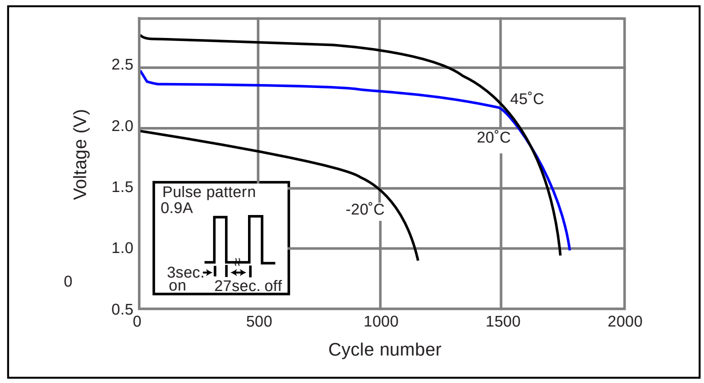


CR123A

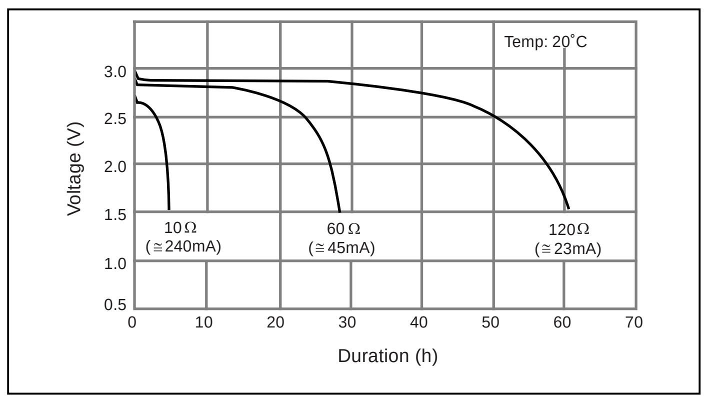
Temperature Characteristics



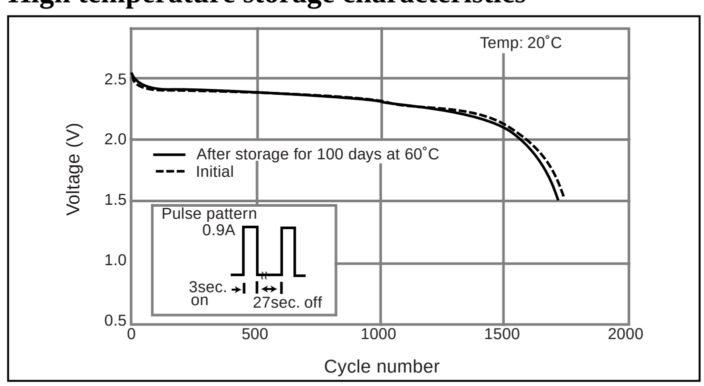
Pulse discharge characteristics



Load characteristics



High temperature storage characteristics



Precautions for handling cylindrical type lithium batteries

Please observe the following precautions to keep the batteries in good condition.

Precautions for storage

- Avoid storing batteries at unusually high or low temperatures.
- Keep batteries in a low-humidity location with little temperature variation. If batteries are kept in a humid place, moisture may condense on them exerting an adverse influence on their electrical characteristics.
- Keep batteries away from direct sunlight.

Precautions in using

- For measuring the battery voltage, use an instrument with an internal resistance of 10 MΩ or higher.
- For measuring internal resistance use an instrument of 1000-Hz a.c. method.
- When mounting batteries with terminals onto a printed circuit board, etc. by dipping in a soldering bath, limit the dipping time to 5 seconds or less; dipping for a longer time may exert an adverse influence on the electrical characteristics such as voltage and capacity. Use extreme caution not to drop batteries into the soldering bath during the dipping; if dropped, batteries may rupture due to abrupt heating. Avoid direct soldering to batteries. Also, do not use reflow soldering.
  * For details, refer to “Guide to correct soldering of lithium batteries with terminals" on page 94.
- Avoid inserting batteries into antistatic materials or wrapping the board mounted with batteries in conductive sheets, which may cause a voltage drop or consumption of the capacity.
  * For details, refer to “Use caution with antistatic conductive materials" on page 96.
- Do not place two or more batteries loosely in a bag or a container; external shorts between batteries may cause a voltage drop or reduced capacity.
- Lithium batteries show a high voltage even when only a slight capacity is left, which can be misunderstood as having sufficient capacity available. When any one of two or more batteries in use together has become exhausted, replace all batteries at the same time, even if they still show a high voltage.
- When two or more batteries are used in series, inversion of polarity may occur in a battery near the end of its life. This indicates that the battery has become exhausted first among the other batteries in use. This is not an abnormal condition.
- If a voltage drop due to shorting, even momentarily, occurs in lithium batteries, it takes time for the voltage to recover. In such a situation, use caution- do not check voltage characteristics of the battery before sufficient recovery of the voltage - or it may lead to a misjudgment that the battery is defective.

Precautions in equipment design

- For mounting batteries, avoid high-temperature locations and protect them from foreign materials.
- Give sufficient consideration to safety when specifying the use of two or more batteries at the same time. Panasonic can help you prepare composite batteries (two or more batteries combined) on request. Do not use single-body batteries by means of a battery holder.
- When different type batteries are to be used together in the equipment circuit, design the circuit so as not to allow the current from the other power source to flow into the lithium battery.
- When lead wires and connection terminals, such as tab terminals, connectors, etc., are needed, Panasonic can supply them on user's request.

Poly carbonmonofluoride (BR series) /manganese dioxide (CR series) lithium batteries

Overview

The Panasonic coin type lithium primary battery is a high-energy, high-density battery resulting from our extensive experience in battery technology. Provided with outstanding features, which conventional dry batteries cannot attain, this battery has a broad range of applications, such as the main power supply of clocks/watches and electronic notebooks, and the memory backup power supply for C-MOS RAM memories and microcomputer IC memories.

Panasonic meets different market needs with two types (30 sizes) of the product offering a wide capacity range (18mAh to l000mAh): poly carbonmonofluoride lithium batteries (BR series) which exhibit stable performance at comparatively high environment temperatures, and manganese dioxide lithium batteries (CR series) which show excellence in comparatively large current applications like the alarm actuation in watches.

Features

- **Voltage about twice that of dry batteries**
  The nominal voltage is as high as 3 V, approximately twice that of manganese and alkaline button batteries. A single lithium battery can replace two or three conventional batteries.
- **Excellent storability with minimal deterioration**
  Minimal deterioration is not necessarily an inherent feature of lithium batteries. It is achieved by using chemically stable materials and superior production methodologies and sealing techniques. Panasonic coin type lithium batteries show an annual deterioration rate as low as about 1.0% at room temperature, meeting the requirement for a room-temperature storage period of more than 10 years.
- **Wide operating temperature range (-40°C to 85°C)**
  Organic solvents are used for the electrolyte in lithium batteries. Therefore, the solidifying point of this electrolyte is much lower than that of the aqueous solution type electrolyte in manganese batteries, etc., enabling the use of lithium batteries in low-temperature regions. Panasonic coin type lithium batteries are mostly operable over the temperature range from -40°C to 85°C.
- **Strong leakage resistance**
  The organic electrolyte liquid used in lithium batteries shows minimal creep. This feature, and our unique sealing technique, give our batteries very strong leakage resistance.
- **UL-recognized product**
  Panasonic coin type lithium batteries have all acquired the component recognition of UL (Underwriters Laboratories Inc.) in U.S..(File No. MH12210)

SPECIFICATION TABLE

Poly carbonmonofluoride (BR series) lithium batteries

Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR1216	---	---	3	25	0.03	12.5	1.60	0.6
BR1220	---	---	3	35	0.03	12.5	2.00	0.7
BR1225	---	BR1225	3	48	0.03	12.5	2.50	0.8
BR1616	---	---	3	48	0.03	16.0	1.60	1.0
BR1632	---	---	3	120	0.03	16.0	3.20	1.5
BR2016	---	BR2016	3	75	0.03	20.0	1.60	1.5
BR2020	---	BR2020	3	100	0.03	20.0	2.00	2.0
BR2032	---	---	3	190	0.03	20.0	3.20	2.5
BR2320	---	BR2320	3	110	0.03	23.0	2.00	2.5
BR2325	---	BR2325	3	165	0.03	23.0	2.50	3.2
BR2330	---	---	3	255	0.03	23.0	3.00	3.2
BR3032	---	BR3032	3	500	0.03	30.0	3.20	5.5

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C

Manganese dioxide (CR series) lithium batteries

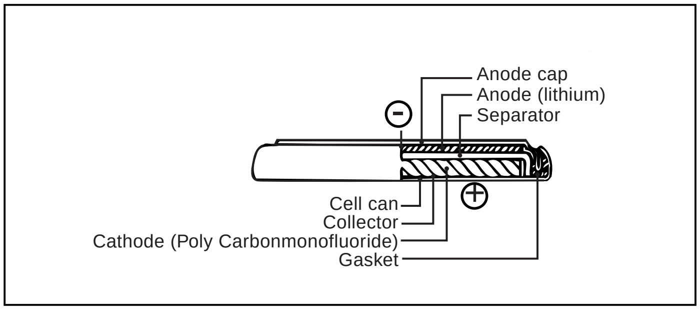
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
CR1025	CR1025	CR1025	3	30	0.10	10.0	2.50	0.7
CR1212 *2	---	---	3	18	0.10	12.5	1.20	0.5
CR1216	CR1216	CR1216	3	25	0.10	12.5	1.60	0.7
CR1220	CR1220	CR1220	3	35	0.10	12.5	2.00	1.2
CR1612	---	---	3	40	0.10	16.0	1.20	0.8
CR1616	CR1616	CR1616	3	55	0.10	16.0	1.60	1.2
CR1620	---	CR1620	3	75	0.10	16.0	2.00	1.3
CR1632	---	---	3	125	0.10	16.0	3.20	1.8
CR2012	CR2012	CR2012	3	55	0.10	20.0	1.20	1.4
CR2016	CR2016	CR2016	3	90	0.10	20.0	1.60	1.6
CR2025	CR2025	CR2025	3	165	0.20	20.0	2.50	2.5
CR2032	CR2032	CR2032	3	220	0.20	20.0	3.20	3.1
CR2320	CR2320	CR2320	3	130	0.20	23.0	2.00	3.0
CR2330	CR2330	CR2330	3	265	0.20	23.0	3.00	4.0
CR2354	---	CR2354	3	560	0.20	23.0	5.40	5.9
CR2412	---	---	3	100	0.20	24.5	1.20	2.0
CR2477	---	---	3	1000	0.20	24.5	7.70	10.5
CR3032	---	CR3032	3	500	0.20	30.0	3.20	7.1

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* 2 Under Development

Applications

- Electronic watches (digital and analog)
- Memory backup for all types of devices (with tab terminal)
- Calculators, cameras, and electronic notebooks
- Electronic clinical thermometers
- Other compact, low power cordless equipment

Cutaway view (BR type)



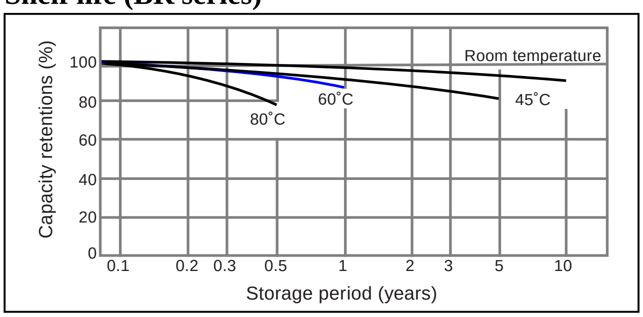
Coin type lithium batteries: size and model number

Diameter mm / Height mm	30	24.5	23	20	16	12.5	10
7.7		CR2477					
5.4			CR2354				
3.2	BR3032 CR3032			BR2032 CR2032	BR1632 CR1632		
3.0			BR2330 CR2330				
2.5			BR2325	CR2025		BR1225	CR1025
2.0			BR2320 CR2320	BR2020	CR1620	BR1220 CR1220	
1.6				BR2016 CR2016	BR1616 CR1616	BR1216 CR1216	
1.2		CR2412		CR2012	CR1612	Δ CR1212	

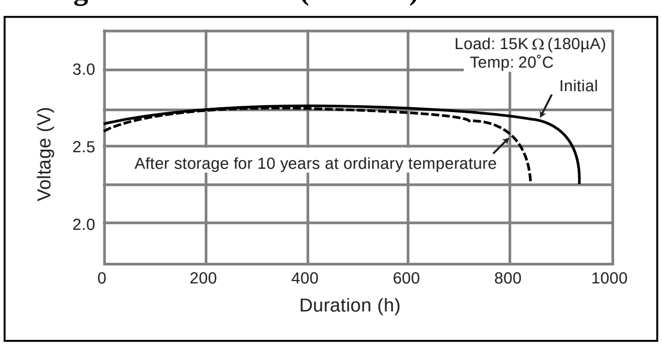
Δ Under development

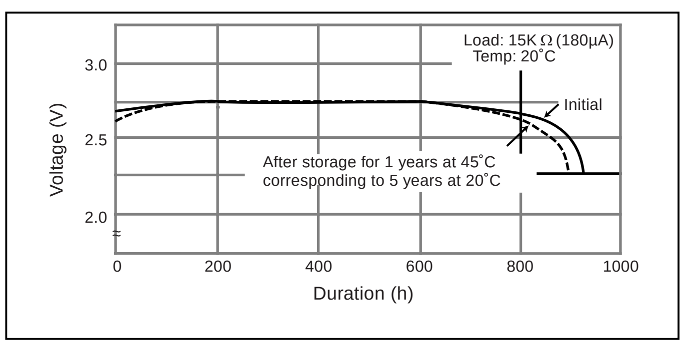
Characteristics

Shelf life (BR series)



Storage characteristics (BR2325)

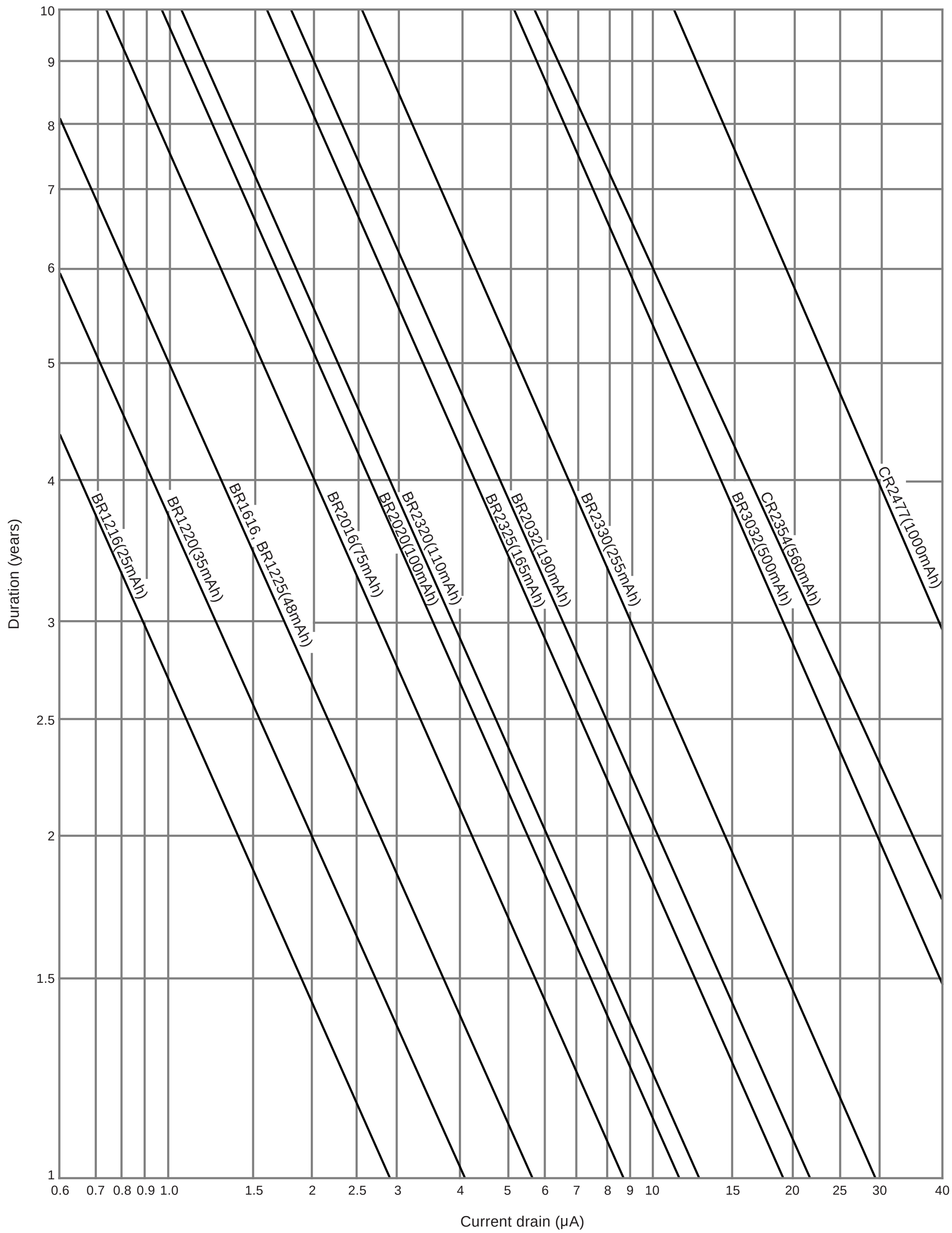




BATTERY SELECTOR CHART

Discharge life as a function of operating current

Temp: 20˚C
Cut off voltage: 2.0V

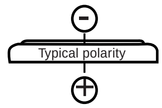


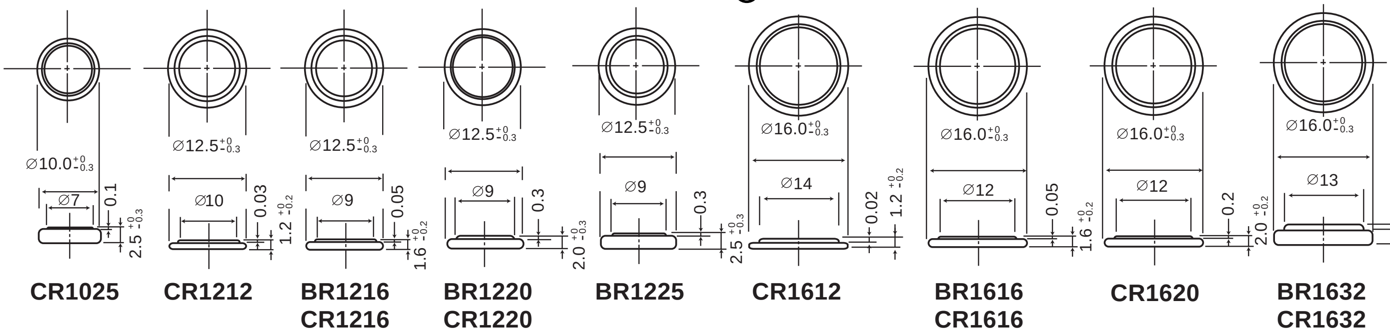
Formula:

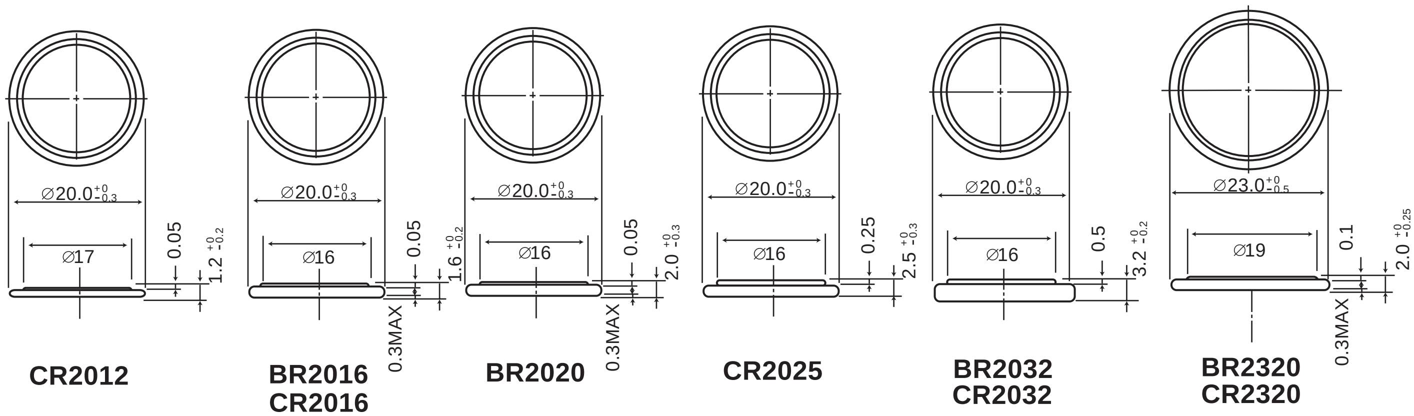
$$\text{Duration (years)} = \frac{\text{Nominal capacity (mAh)}}{\text{Current drain (mA) x 24 (hours) x 365 (days)}}$$

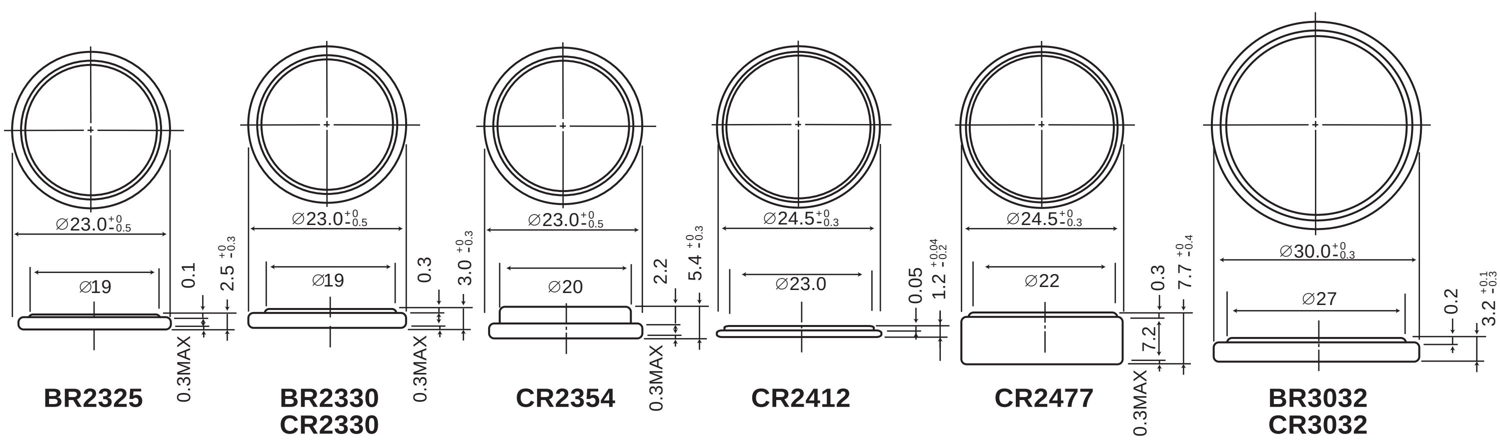
DIMENSIONS (MM)

The dimension data with no tolerance indicated are standard reference values.



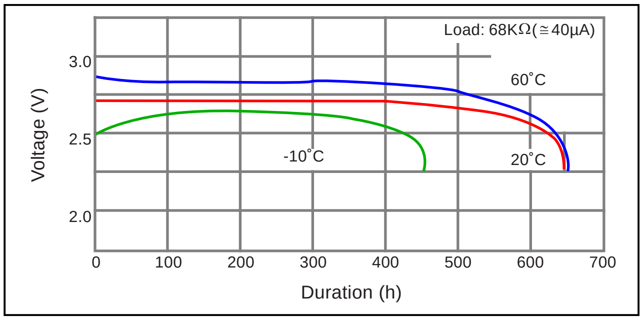




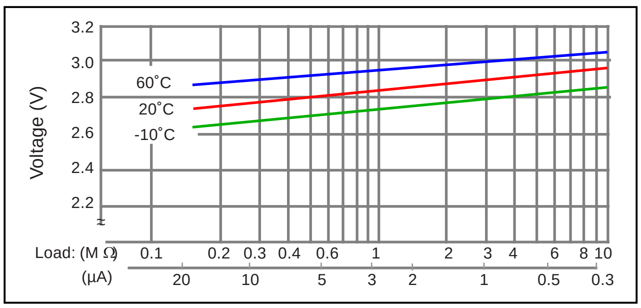


BR1216

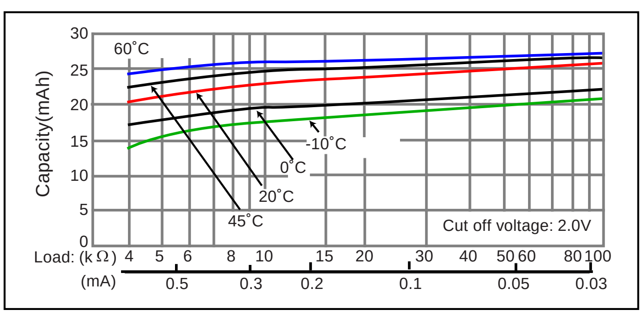
Discharge temperature characteristics



Operating voltage vs. load resistance

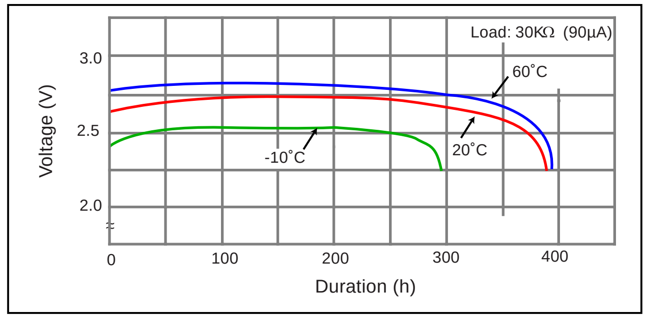


Capacity vs. load resistance

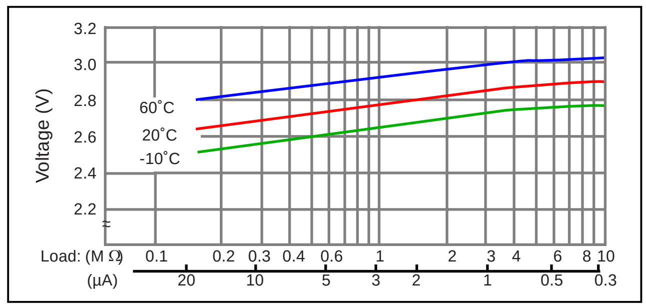


BR1220

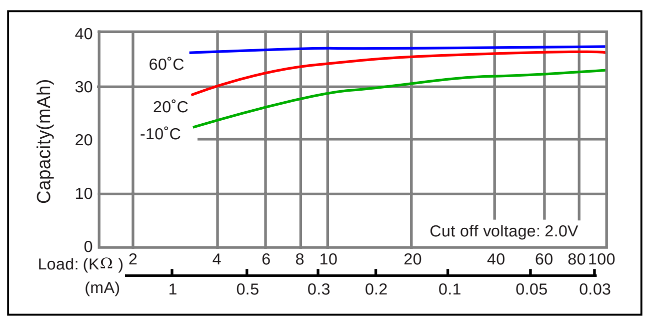
Discharge temperature characteristics



Operating voltage vs. load resistance

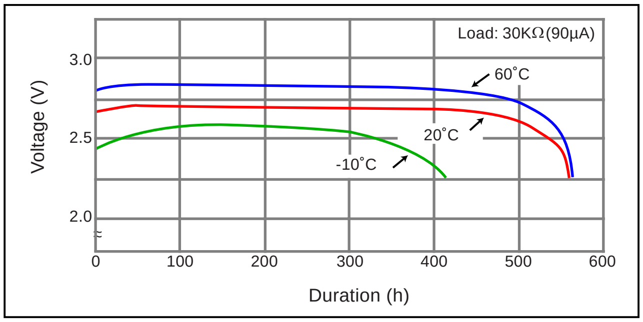


Capacity vs. load resistance

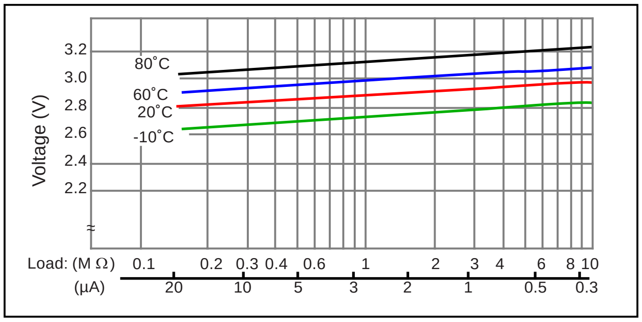


BR1225

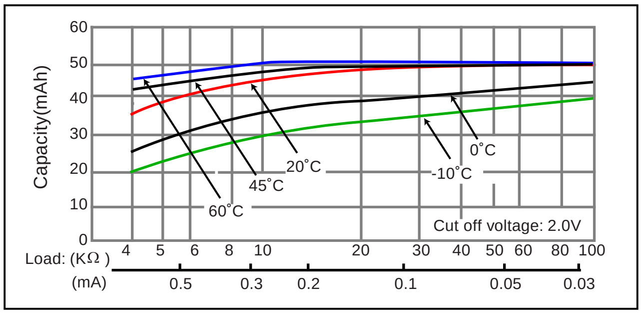
Discharge temperature characteristics



Operating voltage vs. load resistance

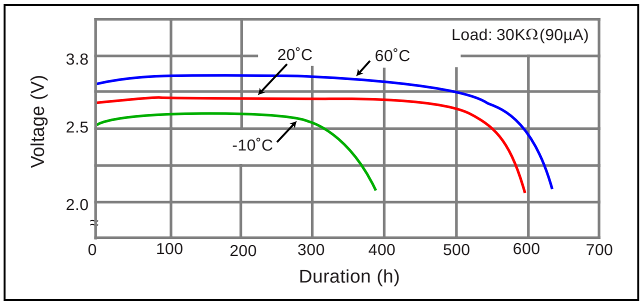


Capacity vs. load resistance

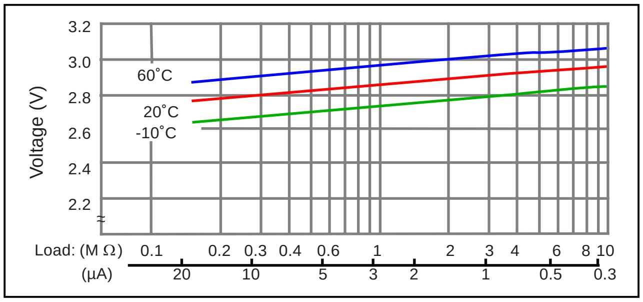


BR1616

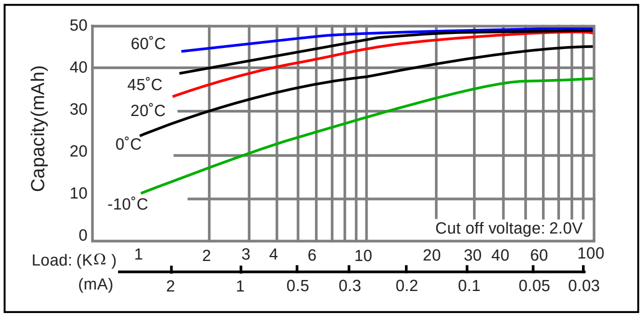
Discharge temperature characteristics



Operating voltage vs. load resistance

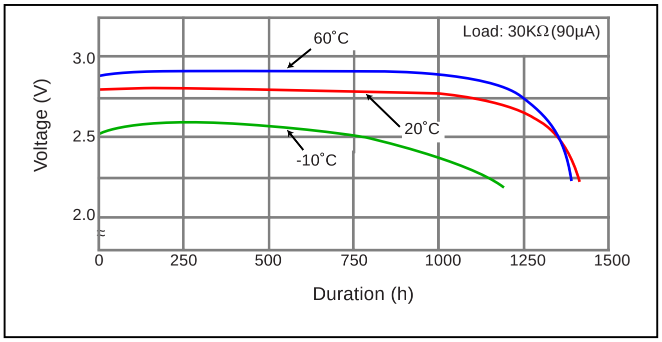


Capacity vs. load resistance



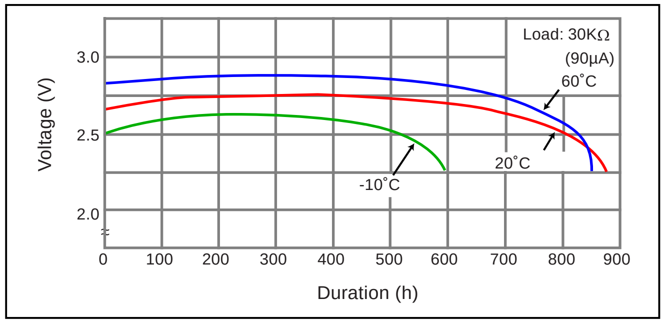
BR1632

Discharge temperature characteristics

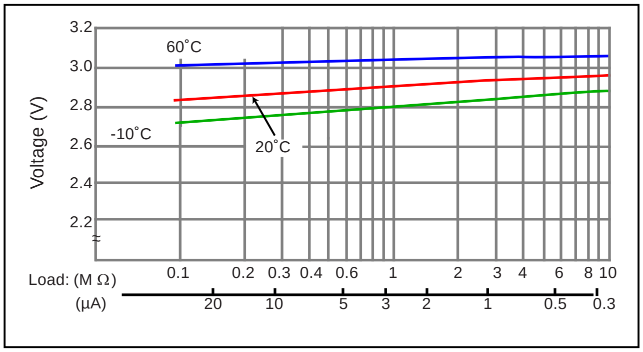


BR2016

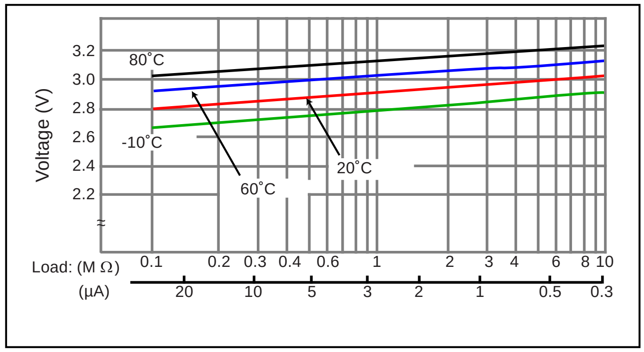
Discharge temperature characteristics



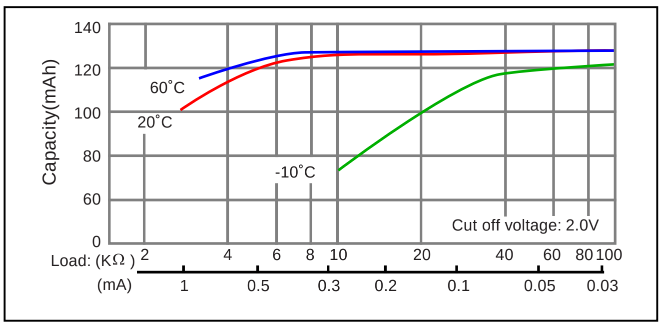
Operating voltage vs. load resistance



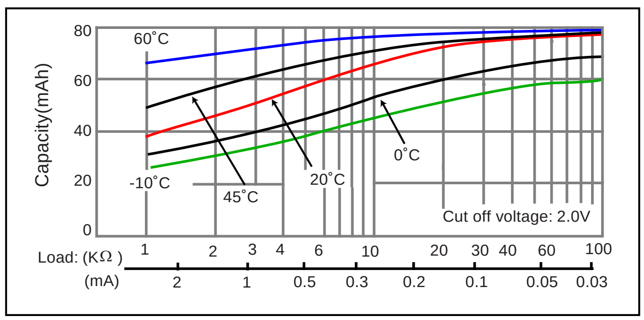
Operating voltage vs. load resistance



Capacity vs. load resistance

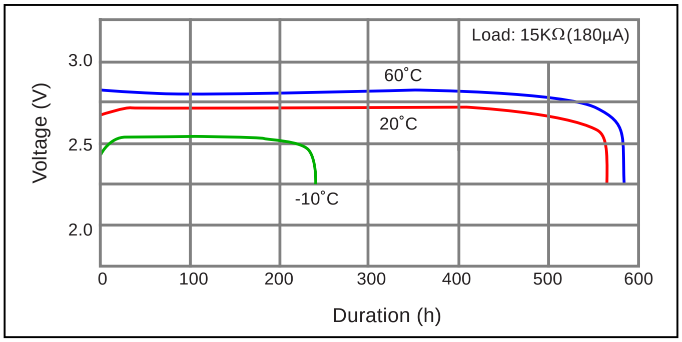


Capacity vs. load resistance

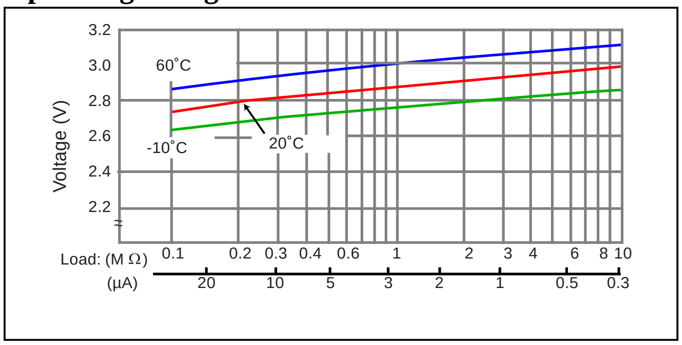


BR2020

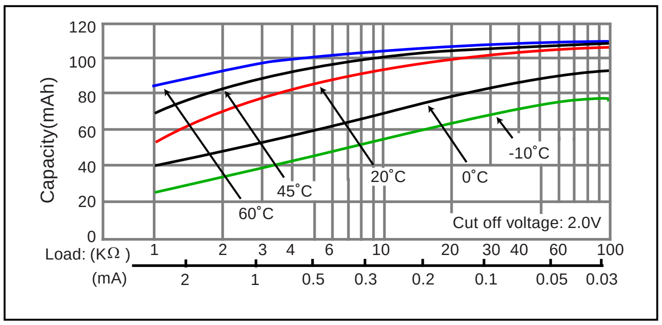
Discharge temperature characteristics



Operating voltage vs. load resistance

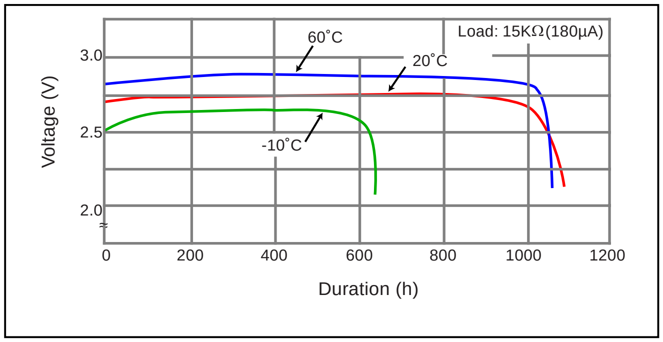


Capacity vs. load resistance

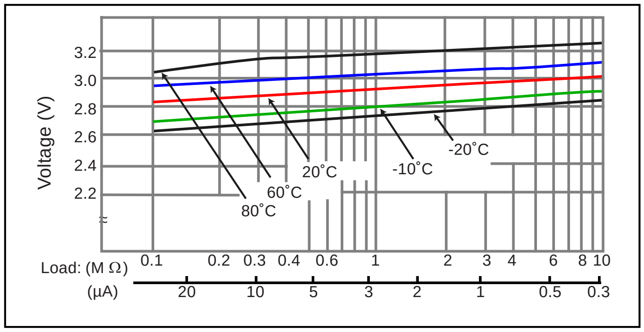


BR2032

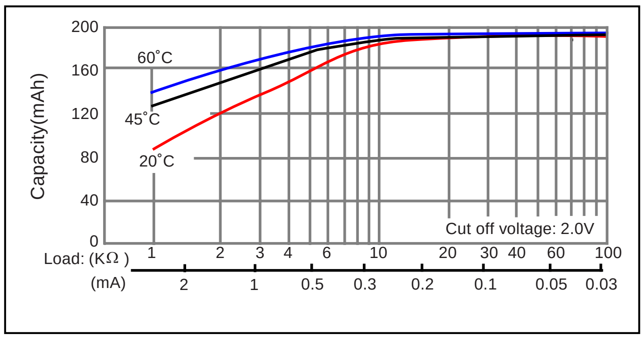
Discharge temperature characteristics



Operating voltage vs. load resistance

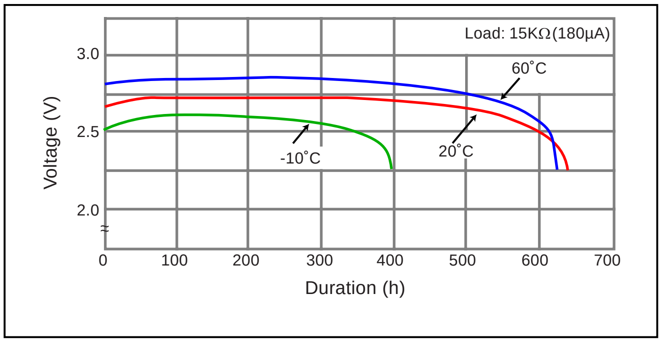


Capacity vs. load resistance

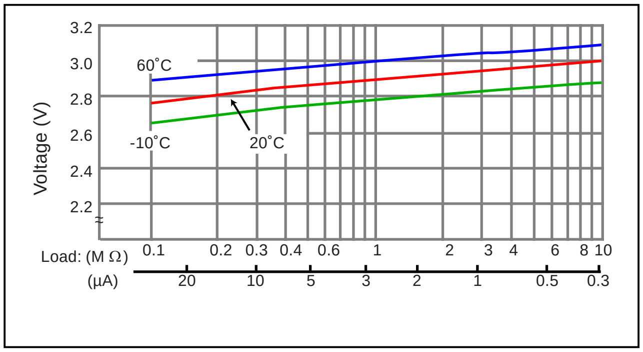


BR2320

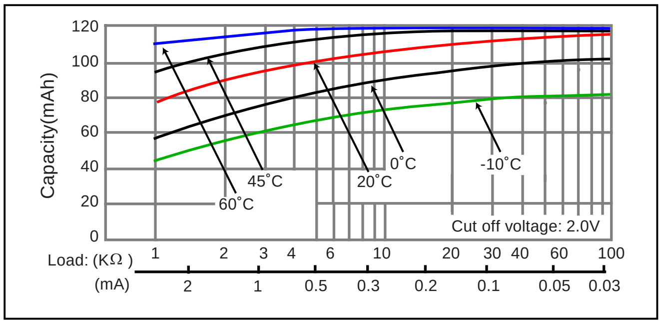
Discharge temperature characteristics



Operating voltage vs. load resistance

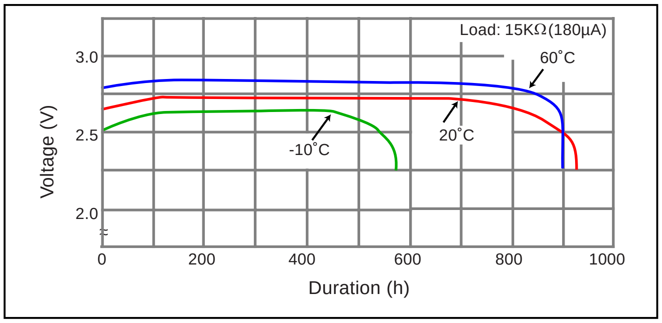


Capacity vs. load resistance

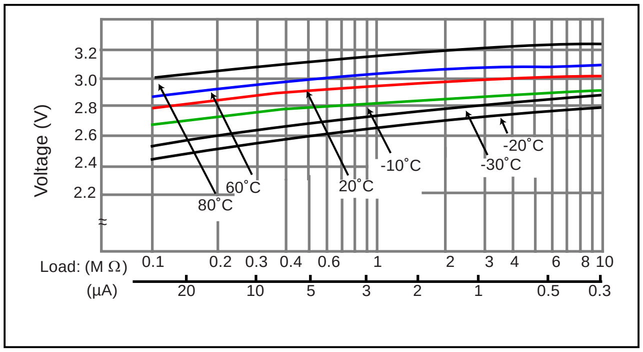


BR2325

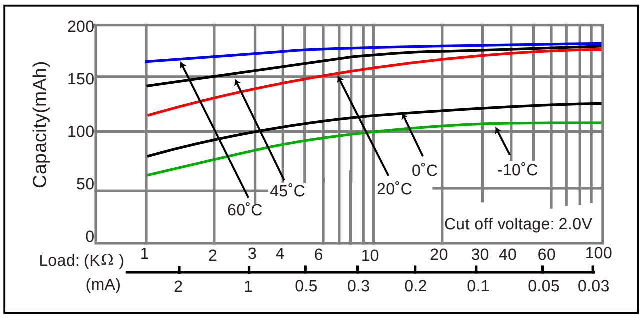
Discharge temperature characteristics



Operating voltage vs. load resistance

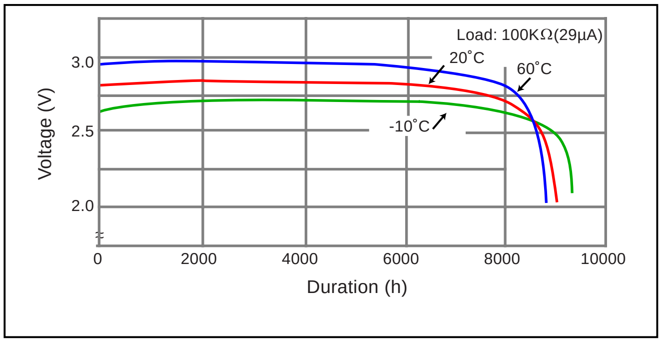


Capacity vs. load resistance

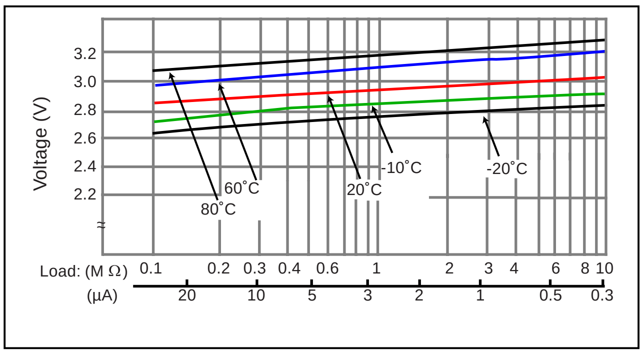


BR2330

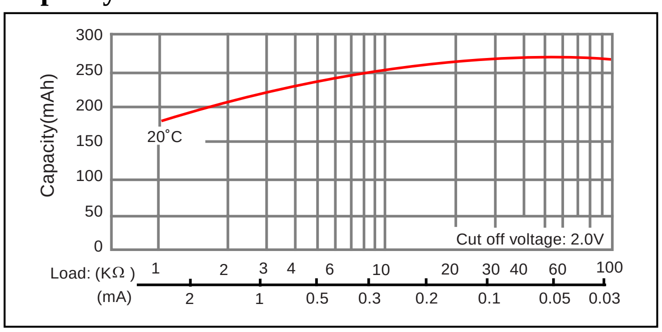
Discharge temperature characteristics



Operating voltage vs. load resistance

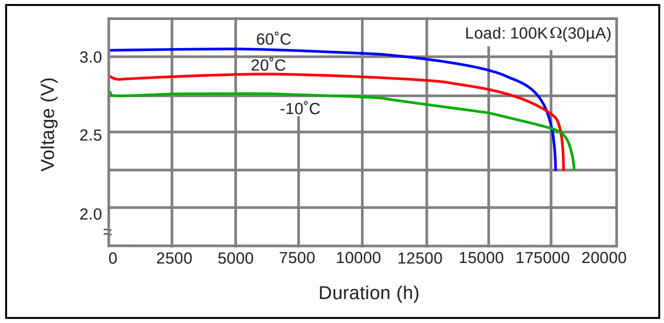


Capacity vs. load resistance

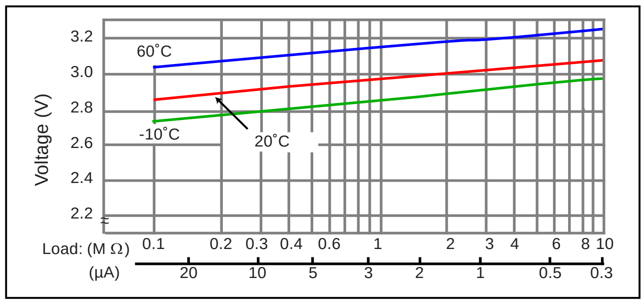


BR3032

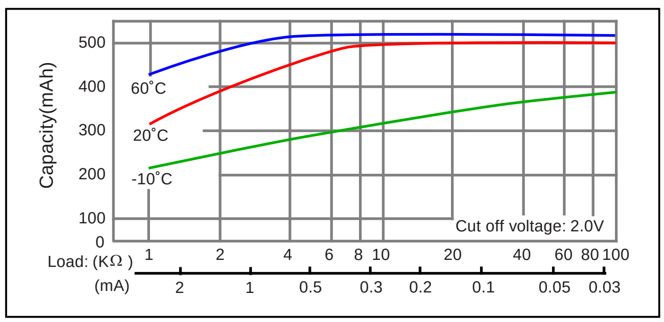
Discharge temperature characteristics



Operating voltage vs. load resistance

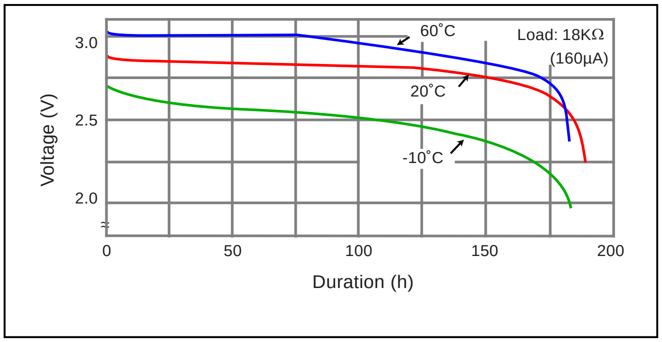


Capacity vs. load resistance

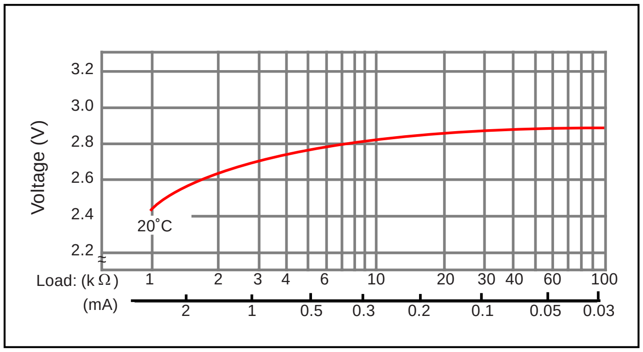


CR1025

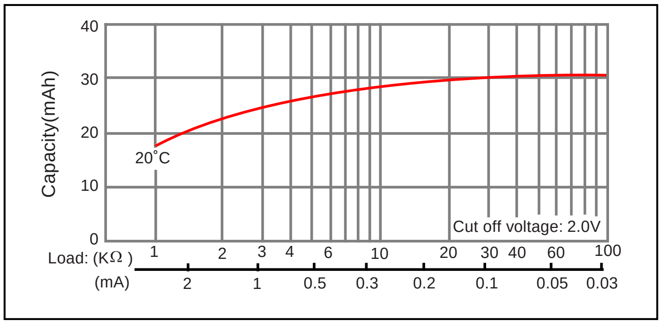
Discharge temperature characteristics



Operating voltage vs. load resistance

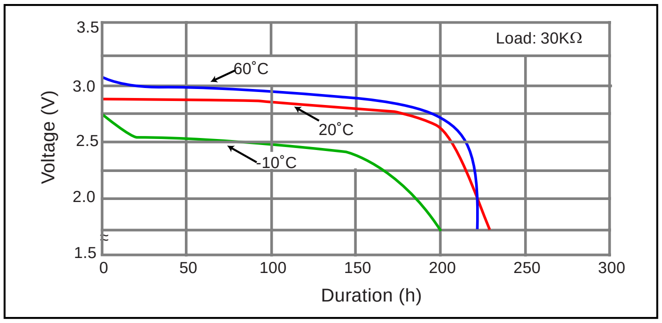


Capacity vs. load resistance

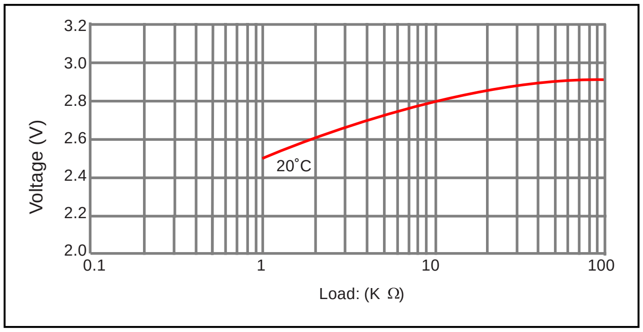


CR1212

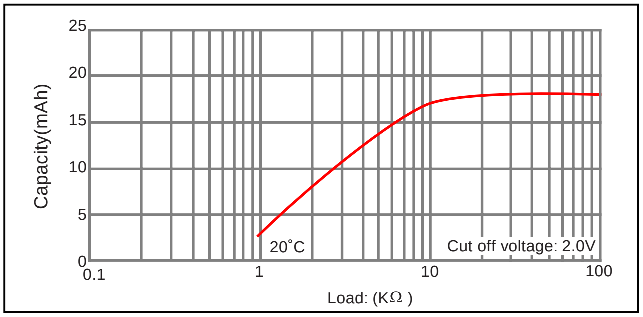
Discharge temperature characteristics



Operating voltage vs. load resistance

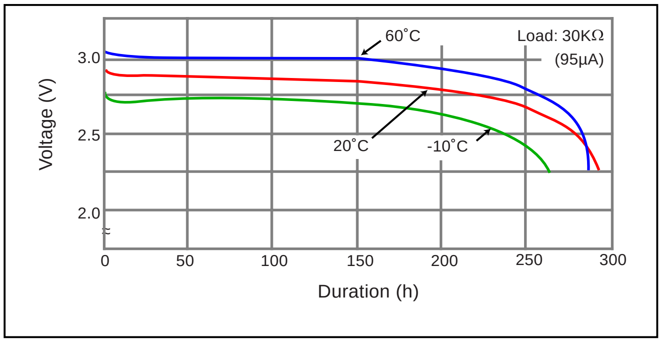


Capacity vs. load

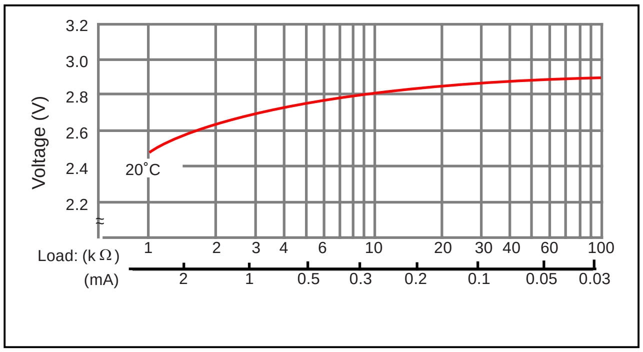


CR1216

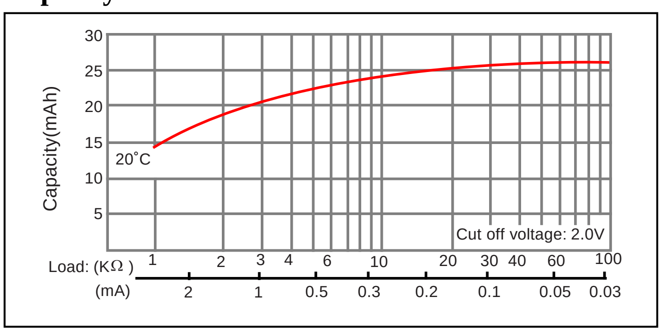
Discharge temperature characteristics



Operating voltage vs. load resistance

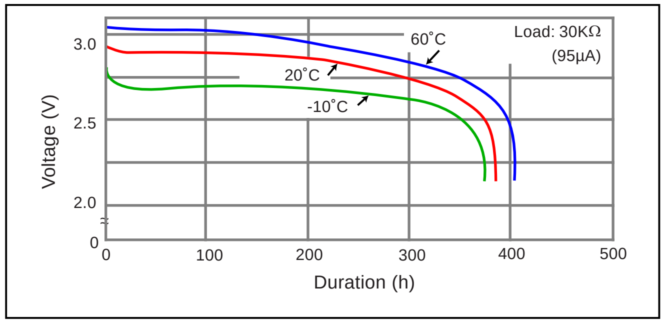


Capacity vs. load resistance

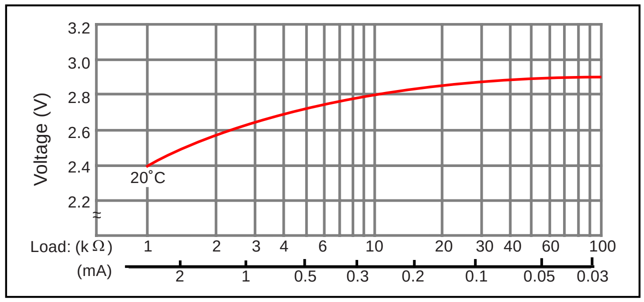


CR1220

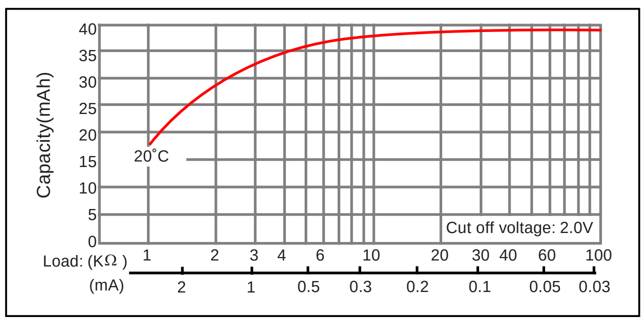
Discharge temperature characteristics



Operating voltage vs. load resistance

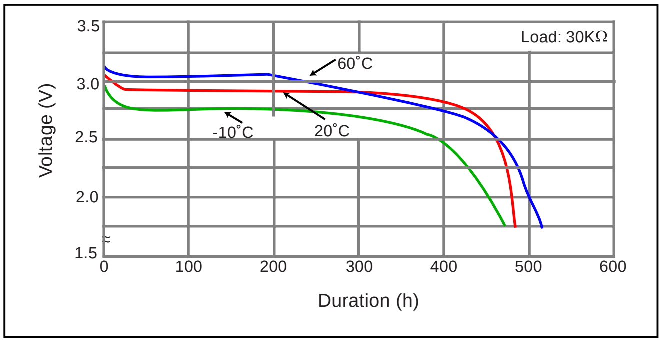


Capacity vs. load resistance

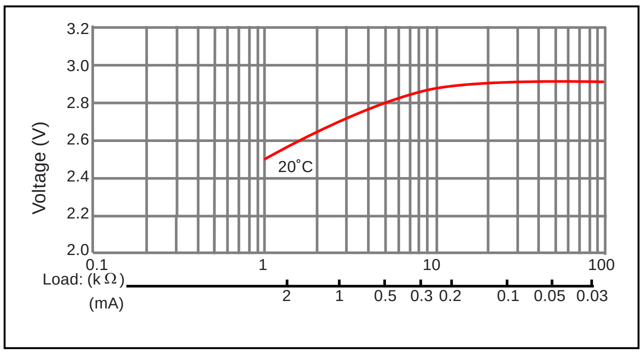


CR1612

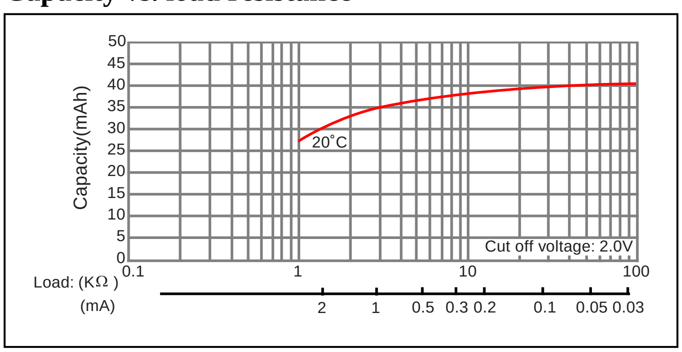
Discharge temperature characteristics



Operating voltage vs. load resistance

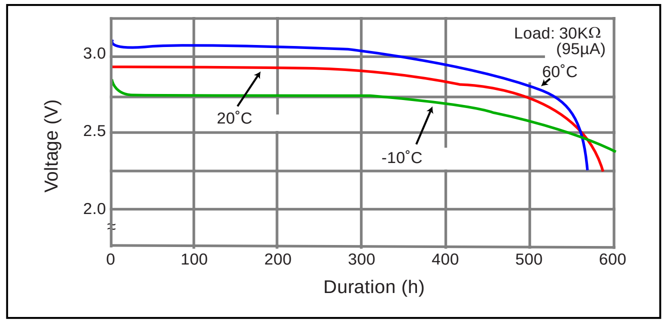


Capacity vs. load resistance

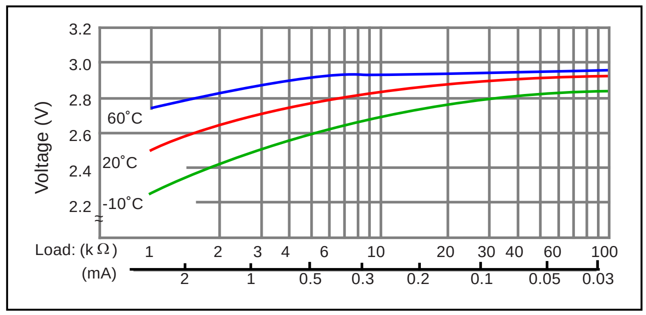


CR1616

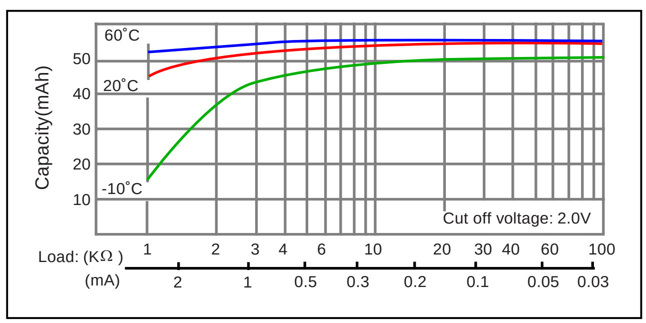
Discharge temperature characteristics



Operating voltage vs. load resistance

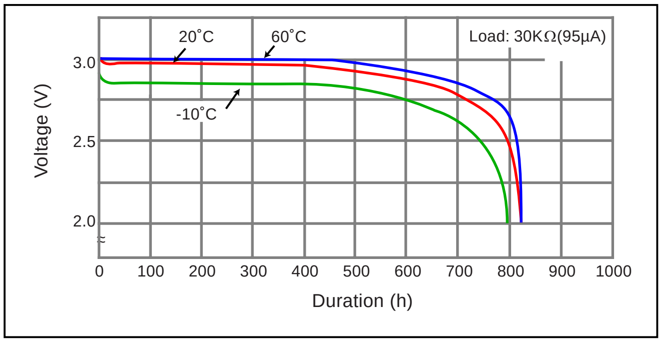


Capacity vs. load resistance

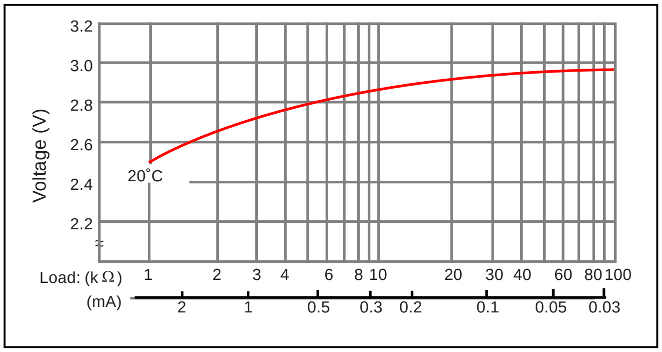


CR1620

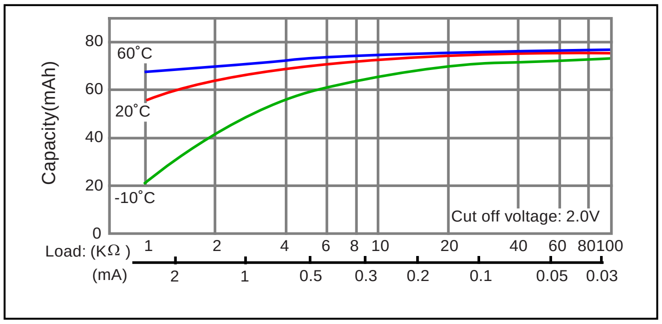
Discharge temperature characteristics



Operating voltage vs. load resistance

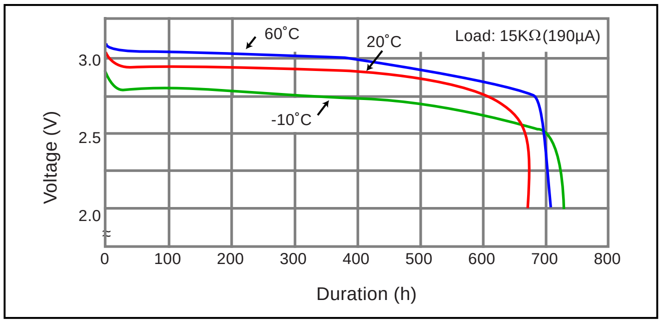


Capacity vs. load resistance

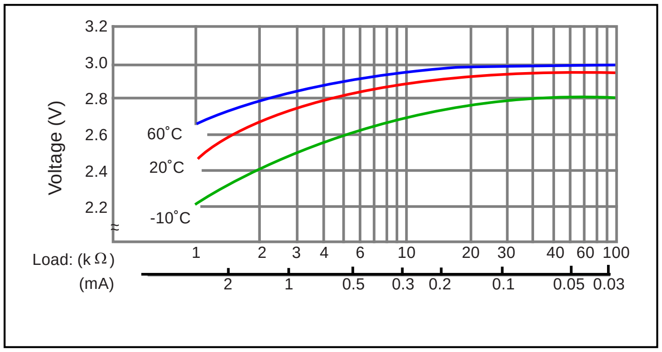


CR1632

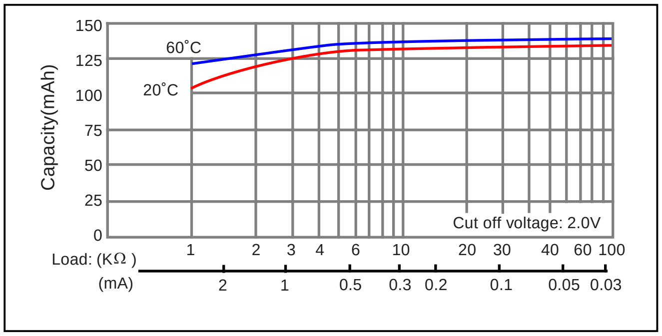
Discharge temperature characteristics



Operating voltage vs. load resistance

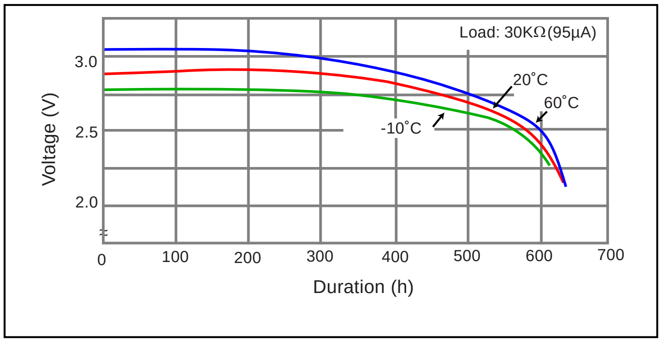


Capacity vs. load resistance

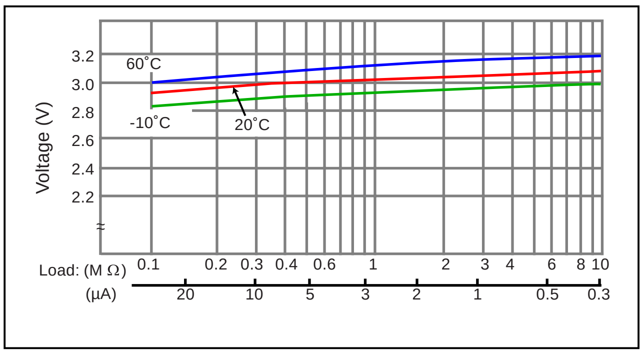


CR2012

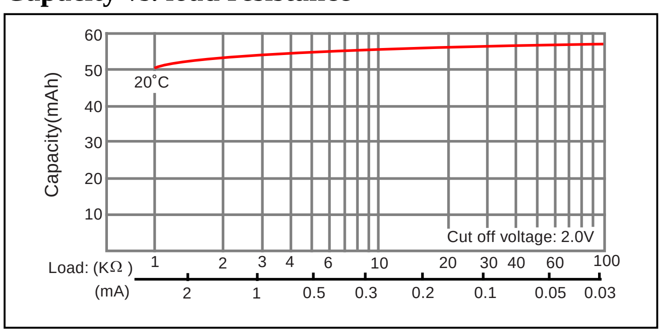
Discharge temperature characteristics



Operating voltage vs. load resistance

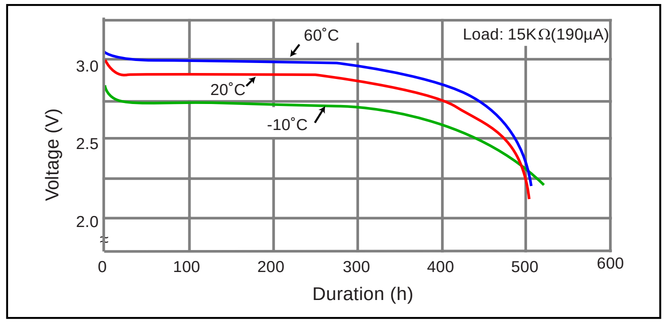


Capacity vs. load resistance

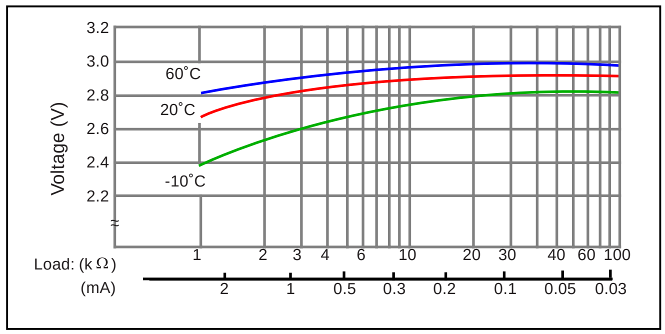


CR2016

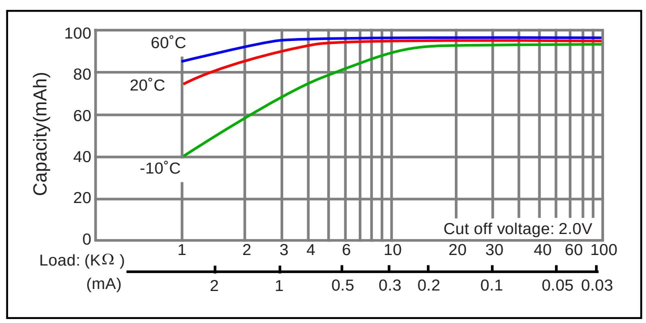
Discharge temperature characteristics



Operating voltage vs. load resistance

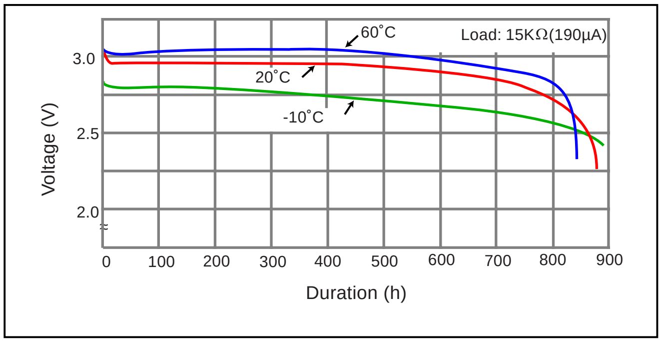


Capacity vs. load resistance

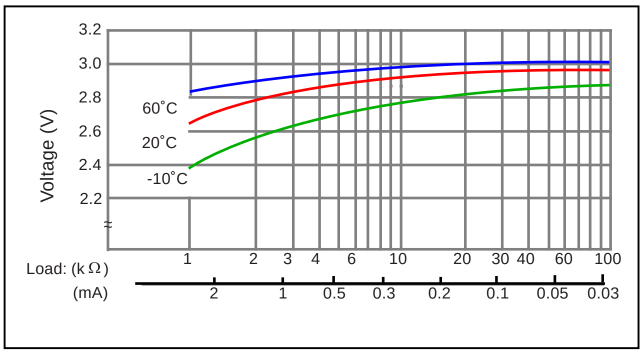


CR2025

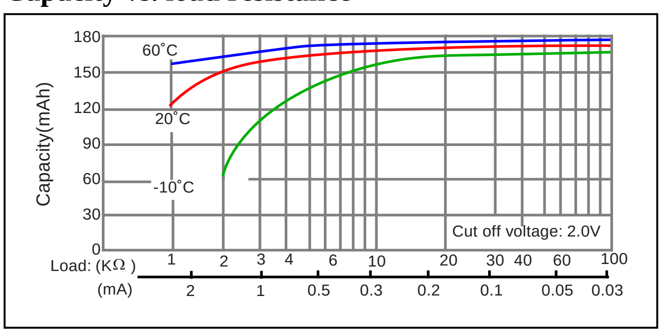
Discharge temperature characteristics



Operating voltage vs. load resistance

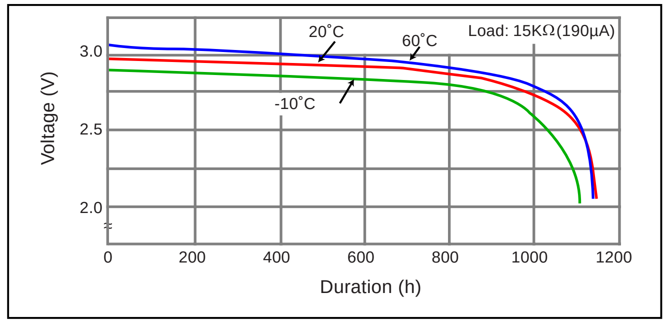


Capacity vs. load resistance

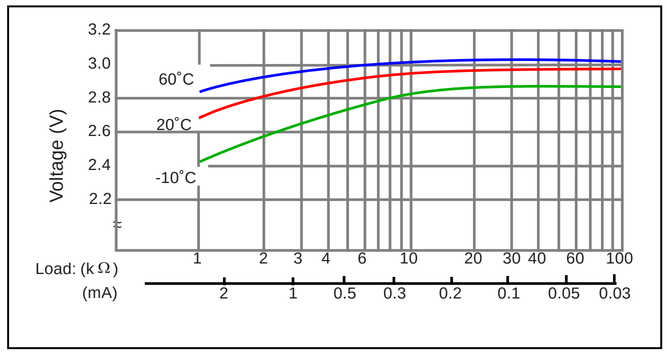


CR2032

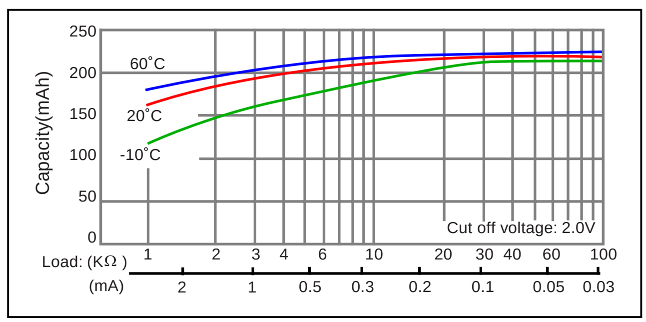
Discharge temperature characteristics



Operating voltage vs. load resistance

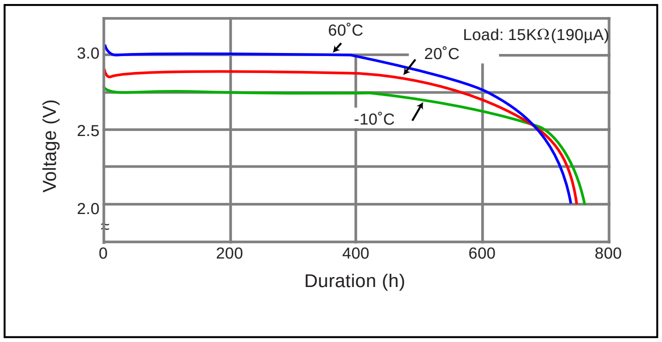


Capacity vs. load resistance

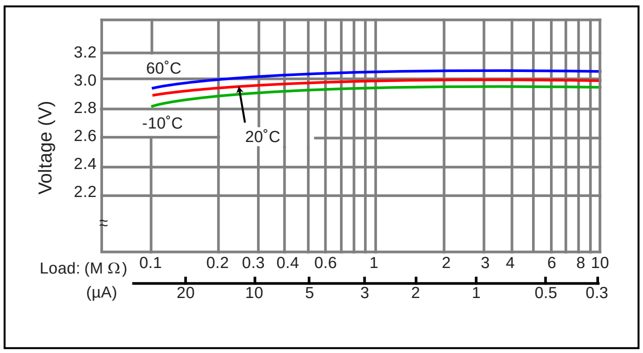


CR2320

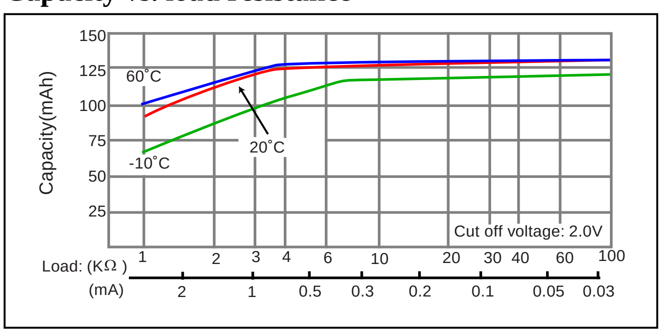
Discharge temperature characteristics



Operating voltage vs. load resistance

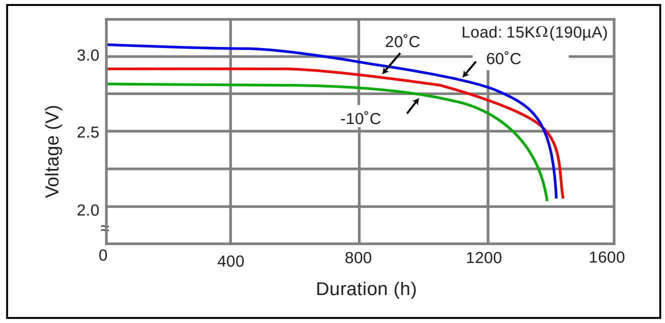


Capacity vs. load resistance

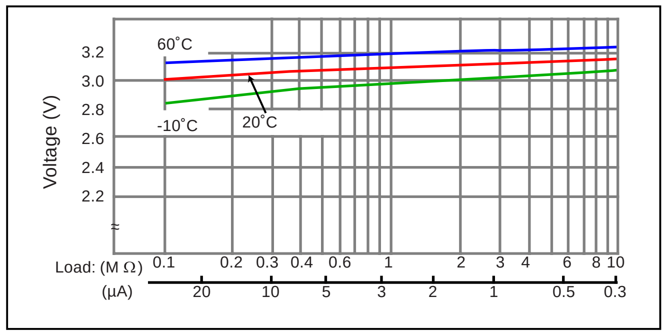


CR2330

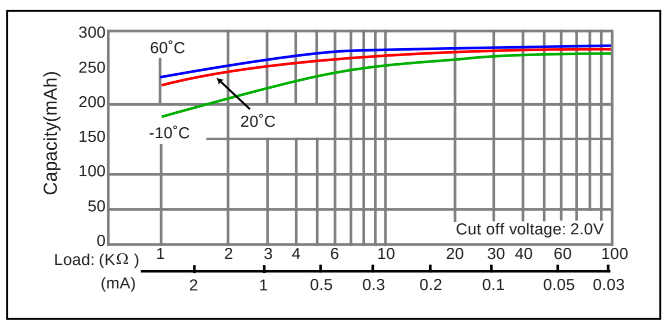
Discharge temperature characteristics



Operating voltage vs. load resistance

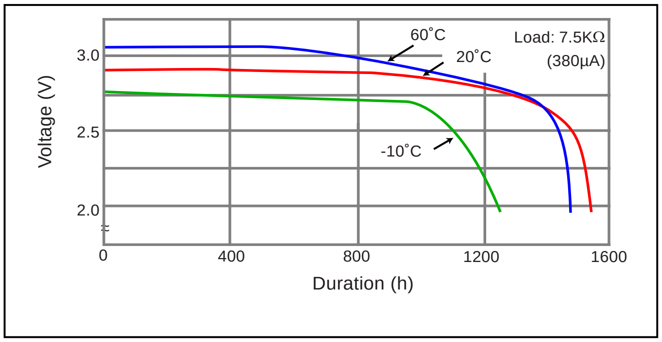


Capacity vs. load resistance

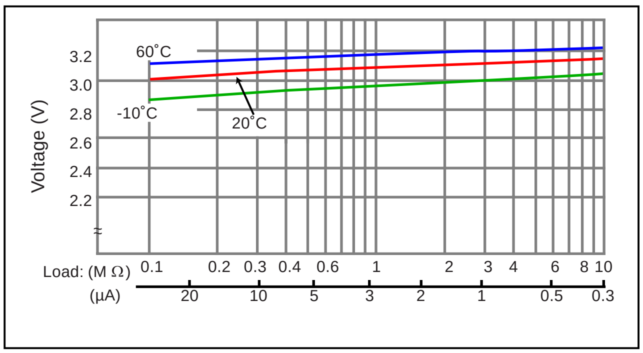


CR2354

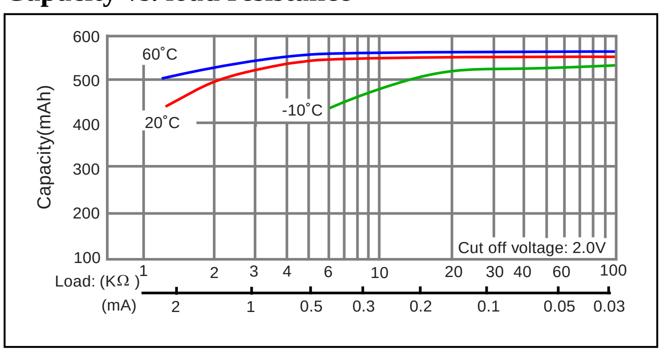
Discharge temperature characteristics



Operating voltage vs. load resistance

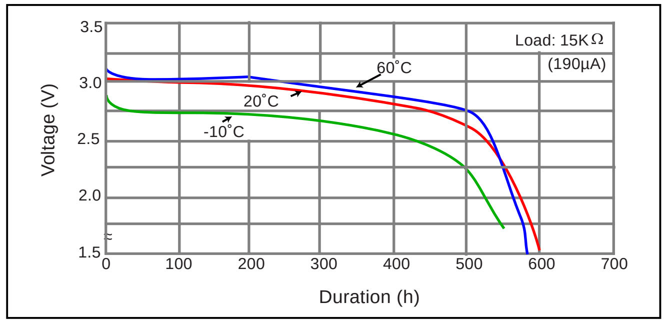


Capacity vs. load resistance

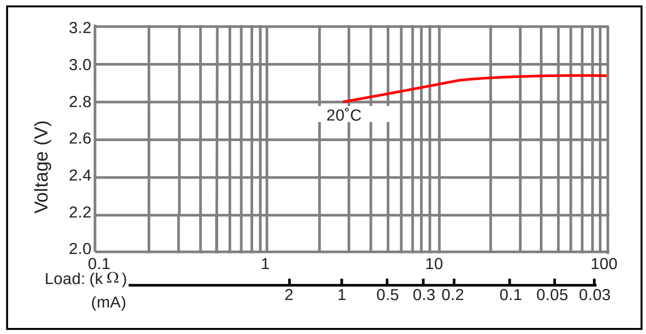


CR2412

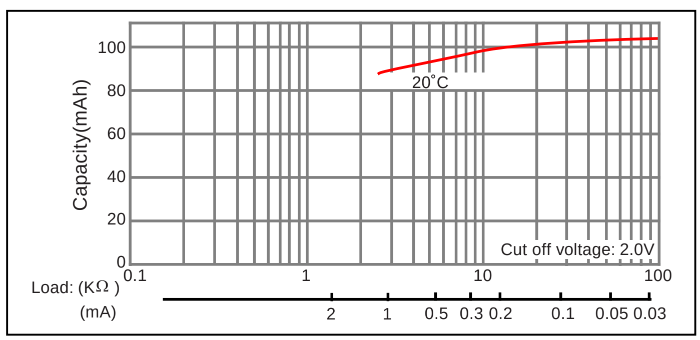
Discharge temperature characteristics



Operating voltage vs. load resistance

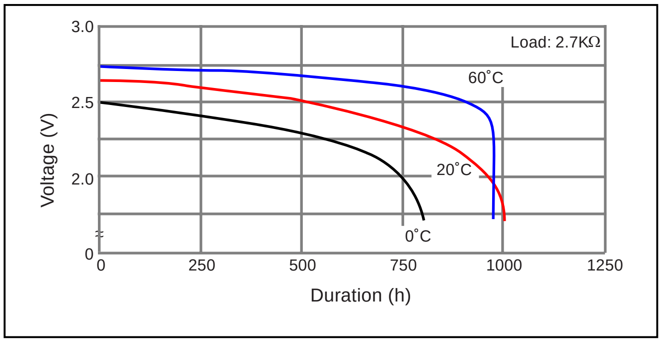


Capacity vs. load resistance

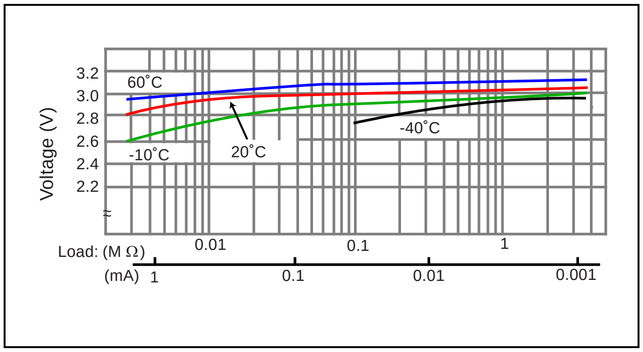


CR2477

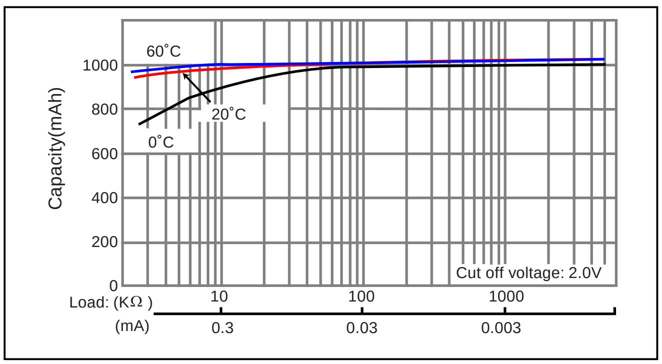
Discharge temperature characteristics



Operating voltage vs. load resistance

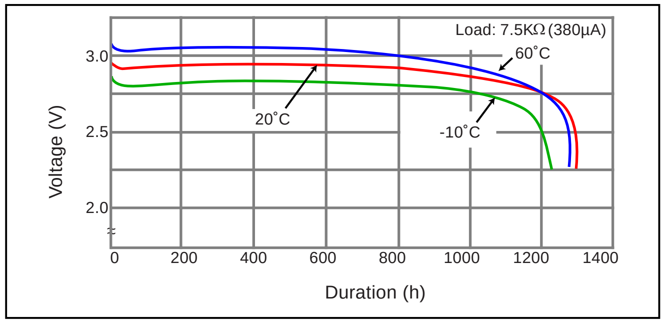


Capacity vs. load resistance

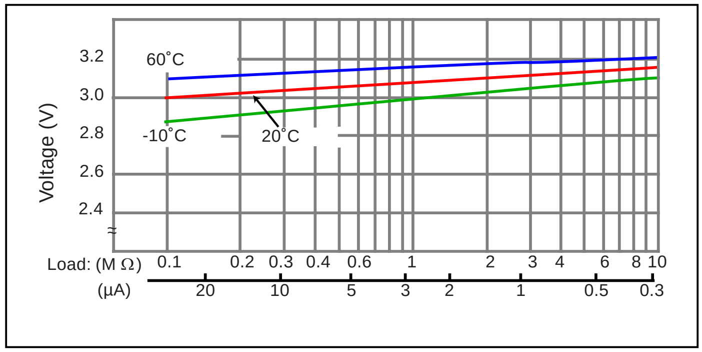


CR3032

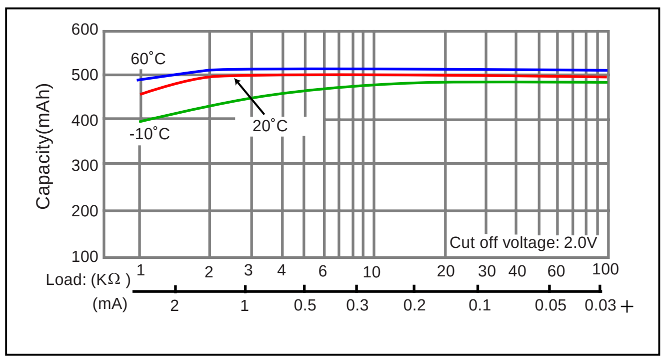
Discharge temperature characteristics



Operating voltage vs. load resistance



Capacity vs. load resistance



COIN TYPE POLY CARBONMONOFLUORIDE (BR SERIES)

Coin type poly carbonmonofluoride (BR series “A” type) lithium batteries for high temperature usage

Overview

We have successfully extended the temperature limits at which coin type poly carbonmonofluoride lithium batteries can be used from the current 85°C to 150°C by replacing the material for the gaskets and separators employed in these coin type lithium batteries with a special engineering plastic and by incorporating an electrolyte with a high boiling point.

Features

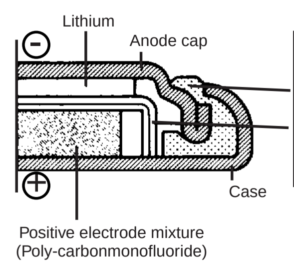
- **Wider operating temperature range**
  The polyolefin plastic used in the past as the material for the gaskets and separators has been replaced with a new special engineering plastic, and an electrolyte with a high boiling point has been adopted. These innovations have made it possible to use the new batteries at a temperature range extending from -40°C to 150°C (-40°C to 125°C with model BR2477A).
- **Excellent storage properties with less self-deterioration**
  Since these batteries are made of lithium, their self-deterioration cannot be described as very low. However, the self-deterioration has been reduced by using chemically stable materials and excellent preparation and sealing technology. The self-deterioration rate over the course of one year at room temperature for Panasonic's coin type lithium batteries has thus been cut to approximately 0.5%. This makes it possible to meet the demand for a storage period of 10 or more years at room temperature.
- **Outstanding resistance to electrolyte leakage**
  The organic electrolyte used for lithium batteries has very low creeping characteristics. The characteristics of this electrolyte and Panasonic's topnotch sealing technology combine to produce outstanding resistance to electrolyte leakage.
- **Approved under UL standards**
  All of Panasonic's coin type lithium batteries have been approved by UL (Underwriters Laboratories Inc.) of the U.S.

Applications

- Back-up power supplies in office automation equipment, factory automation equipment, home electrical appliances, etc.
- Power supplies for automotive electrical parts
- Power supplies for meters

If the desired application requires continuous exposure to temperatures exceeding 120°C, please consult Panasonic in advance.

Cutaway view



	Product developed (Product currently available)
Gasket	Engineering plastic (polypropylene)
Separator	Engineering plastic (polypropylene)
Electrolyte	LiBF4/GBL (LiBG4/GBL & DME)

Specification Table

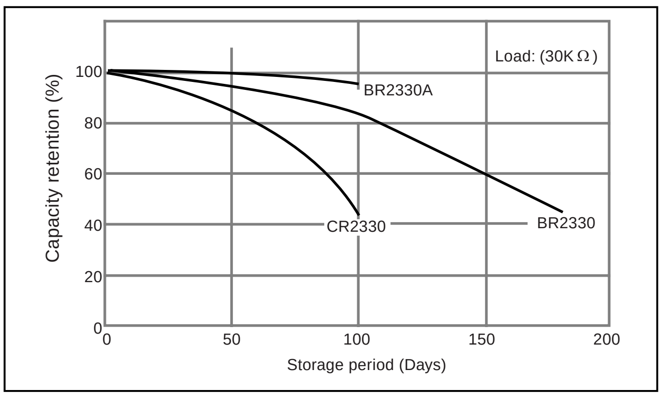
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
BR1225A *2	---	---	3	48	0.03	12.5	2.50	0.8
BRl632A	---	---	3	120	0.03	16.0	3.20	1.5
BR2330A	---	---	3	255	0.03	23.0	3.00	3.2
BR2477A	---	---	3	1000	0.03	24.5	7.00	8.0

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C
* 2 Under Development

Type	Model No.	P.V.C. Cover		Characteristics		BR, CR
		With P.V.C. cover	Without P.V.C. cover	Nominal Voltage (V)	Nominal capacity (mAh)	
H type	BR2477A/HB	⊗		3	1000	CR2477/1HF
	BR2477A/HC		⊗	3	1000	CR2477/1HE
	BR2330A/HA	⊗		3	255	CR2330/1HT
	BR2330A/HB		⊗	3	255	CR2330/1HT
	BR1632A/HA	⊗		3	120	CR1632/1HF
	BR1632A/HB		⊗	3	120	CR1632/1HE
V type	BR2477A/VA	⊗		3	1000	CR2477/1VC
	BR1632A/VA	⊗		3	120	BR1632/V1A
F type	BR1632A/FA	⊗		3	120	CR1632/1F2
Others	BR2330A/GA		⊗	3	255	CR2330/1GU

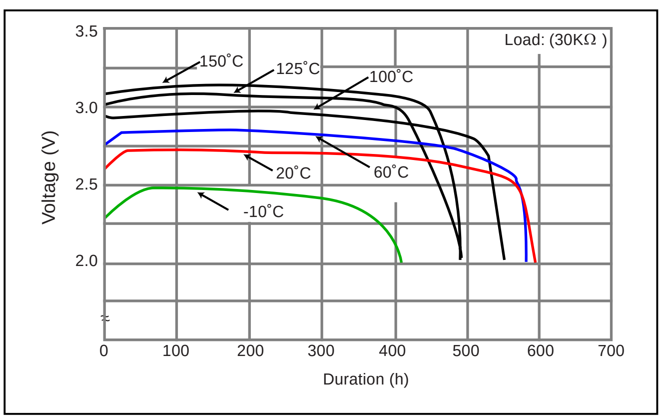
Characteristics

Storage Characteristics (100°C)

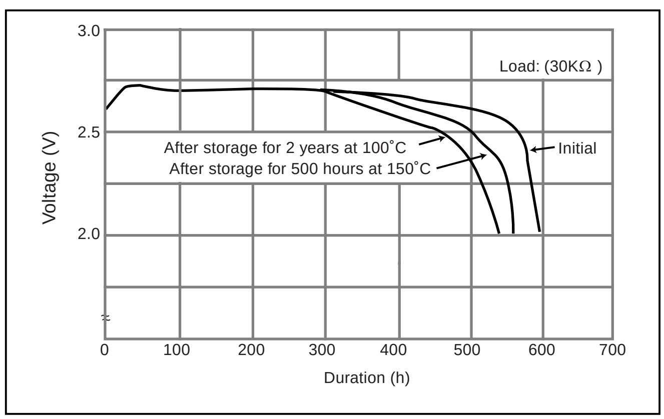


BR1225A

Discharge temperature characteristics-BR1225A

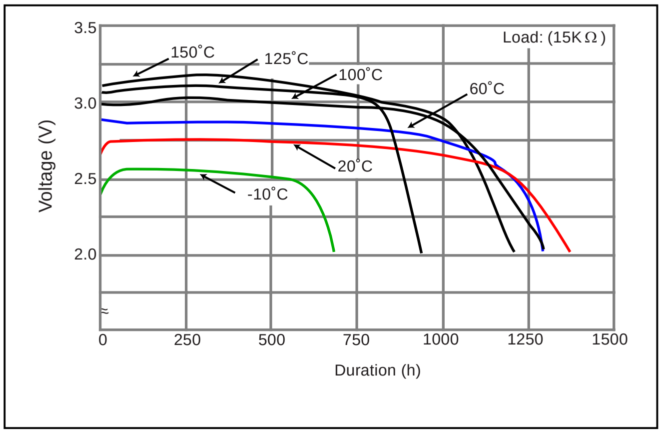


Storage Characteristics (100°C)

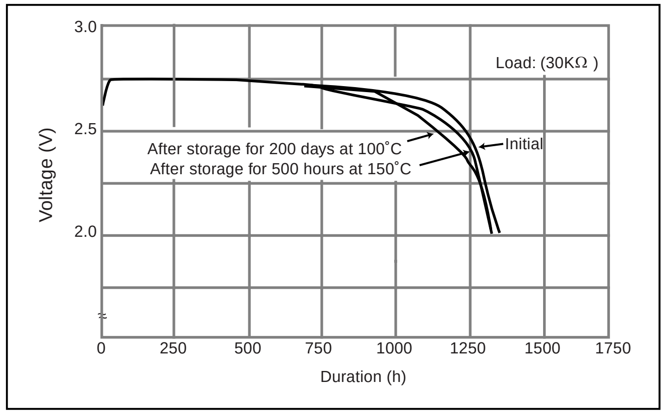


BR1632A

Discharge temperature characteristics

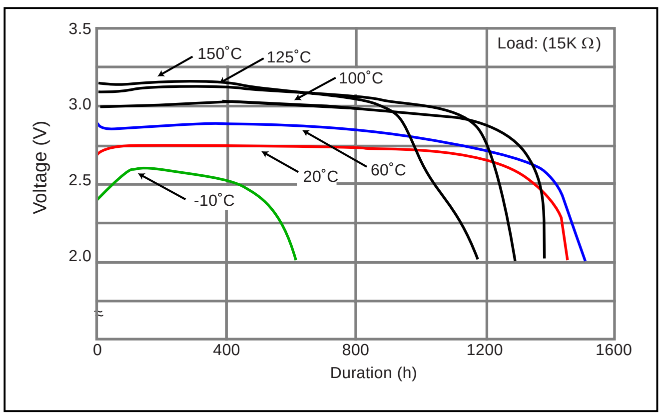


Storage Characteristics

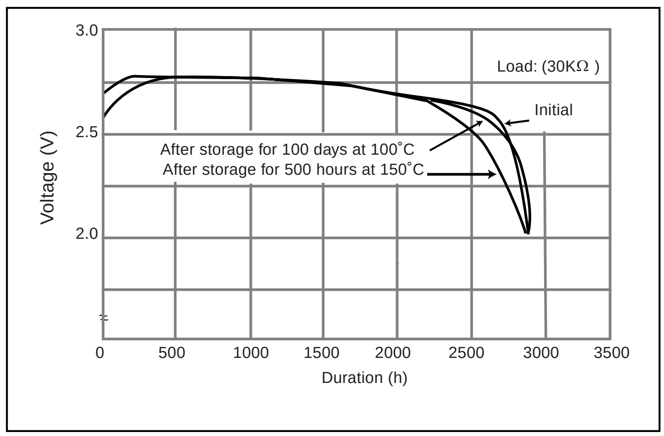


BR2330A

Discharge temperature characteristics

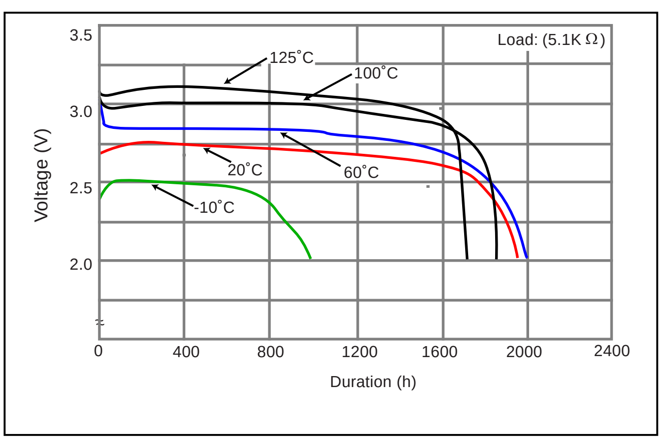


Storage Characteristics

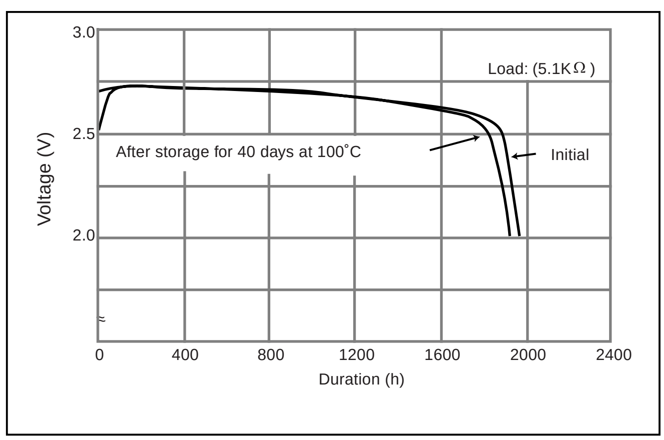


BR2477A

Discharge temperature characteristics



Storage Characteristics



Precautions for handling coin type lithium batteries

Please observe the following precautions to keep batteries in good condition.

Precautions for storage

- Avoid storing batteries at unusually high or low temperatures.
- Store batteries in a low-humidity location with little temperature variation. If batteries are stored in a humid place, moisture may condense on them, exerting an adverse influence on their electrical characteristics.
- Keep batteries away from direct sunlight.

Handling precautions

- When measuring the battery voltage, use an instrument with an internal resistance of 10 MΩ or higher.
- Before loading batteries in equipment, check that the terminals are clean and not deformed; if dirty, clean and dry the terminals before loading batteries.
- Batteries of different types or grades have different characteristics even when they have the same size and shape. Carefully check the labels on batteries when replacing.
- Lithium batteries show a high voltage even when only a slight capacity is remaining, which can be misunderstood as having sufficient capacity available. When any one out of two or more batteries in use together is exhausted, replace all batteries at the same time, even if they still show a high voltage.
- When mounting batteries with terminals onto a printed circuit board, etc. by dipping in a soldering bath, limit the dipping time to 5 seconds or less; dipping for a longer time may exert an adverse influence on the electrical characteristics such as voltage and capacity. Use extreme caution not to drop batteries into the soldering bath during the dipping; if dropped, batteries may rupture due to abrupt heating. Avoid direct soldering to batteries. Also, do not use reflow soldering.
  * For details, refer to "Guide to correct soldering of lithium batteries with terminals" on page 94.
- Avoid inserting batteries into antistatic materials or wrapping the board mounted with batteries in conductive sheets, which may cause a voltage drop or consumption of the capacity.
  * For details, refer to "Use caution with antistatic conductive materials" on page 96.
- Do not put two or more batteries loosely in a bag or container; external shorting between batteries may cause voltage drop or consumption of the capacity.
  * For details, refer to "Use caution in allowing batteries to contact each other" on page 97.
- When two or more batteries are used in series, inversion of polarity may occur in a battery near the end of its life. This indicates that the battery has become exhausted first. This is not an abnormal condition.
- If a voltage drop due to shorting, even momentarily, occurs in lithium batteries, it takes a period of time for the voltage to recover. In such a situation, use caution not to check the voltage of the battery before sufficient recovery time, or it may lead to a misjudgment that the battery is defective.

Precautions in equipment design

- For mounting batteries, avoid high-temperature locations and protect them from foreign materials.
- When a battery and another power source are to be used together in the equipment circuit, design the circuit so as not to allow a current from the other power source to flow into the battery.
- If lead wires and connection terminals such as tab terminals are needed for batteries, Panasonic can supply external terminals (connectors, etc.) on request.
- For the contact point on power supply terminals, use nickel-plated iron, nickel-plated stainless steel or higher grade materials.
- For ensuring stable contact, apply a contact pressure of 2N~10N (approx. 200~1000 gf).
  * For details, refer to "Ensuring positive battery contact with equipment" on page 95.

RECHARGEABLE COIN TYPE LITHIUM BATTERIES

Vanadium pentoxide lithium rechargeable batteries (VL series)

Overview

This coin type lithium rechargeable battery has a totally new composition, employing vanadium pentoxide cathode, lithium alloy anode, and non-aqueous solvents in the electrolyte solution. With an energy density about twice that of button type nickel cadmium batteries, this battery is especially suited for applications such as memory backup power supply in electronic devices.

Applications

- Memory backup power supplies for OA equipment (personal computers, facsimiles, etc.), AV equipment (VTRs), and communications equipment (portable telephones, etc.)
- Hybrid systems with solar batteries (solar remote controls, etc.)

Features

- **Flat high voltage of about 3 V**
  A single battery can provide the voltage equivalent to two or even three nickel cadmium batteries (approx. 1.2 V) and capacitors. Benefits include: Compact design and cost reduction.
- **Several months of continuous backup**
  VL3032 (nominal capacity l00mAh) is capable of continuous backup for 10,000 hours at a memory backup load of 10µA (when discharged to 2.5 V).
- **Small self-discharge allows use without recharging even after long storage**.
  Unlike nickel cadmium batteries which lose considerable capacity in 6 months due to self-discharge, the vanadium lithium secondary battery's self-discharge is very small, i.e., annual rate of approximately 2% at normal temperature.
- **Stable to continuous overcharging and overdischarging.**
  Vanadium lithium batteries exhibit stable characteristics in continuous overcharging and overdischarging to 0V, important in memory backup considerations.

Specification Table

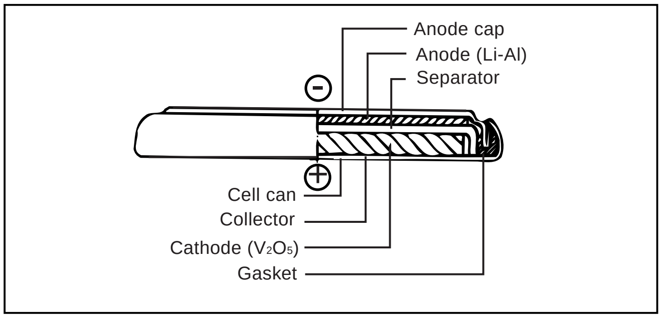
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
VL621	---	---	3	1.5	0.01	6.8	2.1	0.3
VL1216	---	---	3	5	0.03	12.5	1.6	0.7
VL1220	---	---	3	7	0.03	12.5	2.0	0.8
VL2020	---	---	3	20	0.07	20.0	2.0	2.2
VL2320	---	---	3	30	0.10	23.0	2.0	2.8
VL2330	---	---	3	50	0.10	23.0	3.0	3.7
VL3032	---	---	3	100	0.20	30.0	3.2	6.3

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.5 V at 20°C

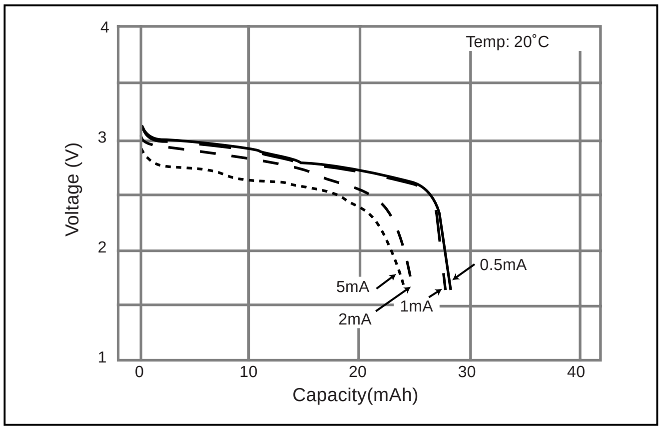
Charge and discharge cycle	About 1,000 times at 10% discharge depth to nominal capacity
Charge	Constant-voltage charging (Refer to recommended charging circuit)
Operating temperature	-20°C to 60°C

RECHARGEABLE COIN TYPE LITHIUM BATTERIES

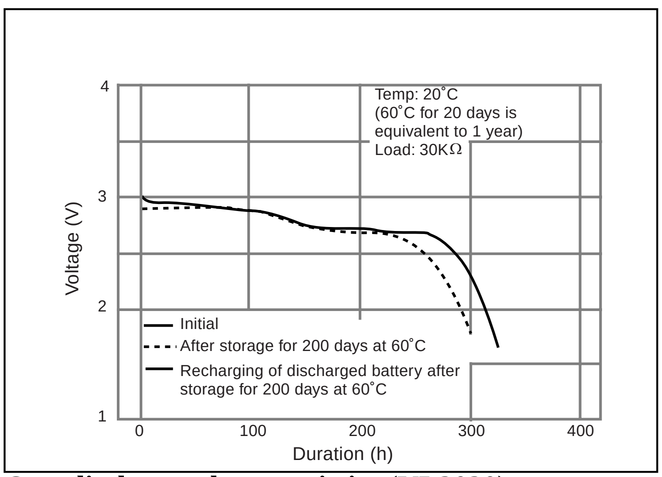
Cutaway view



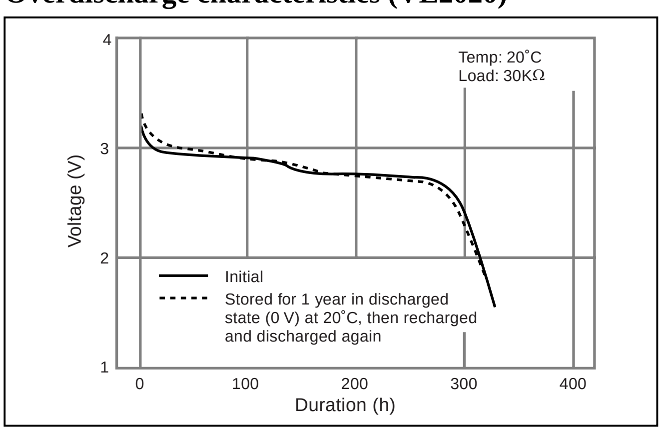
Load characteristics (VL2020)



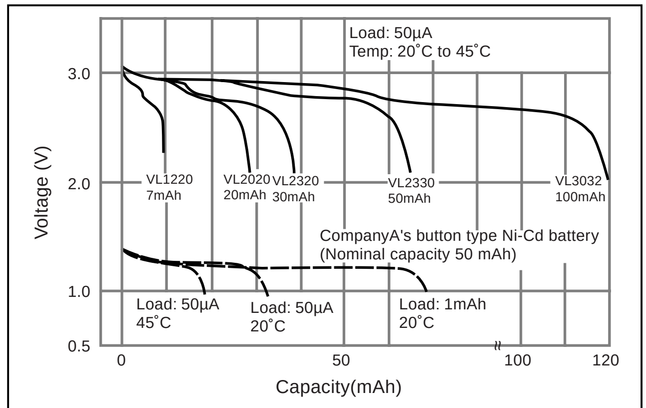
Storage characteristics (without charge) (VL2020)



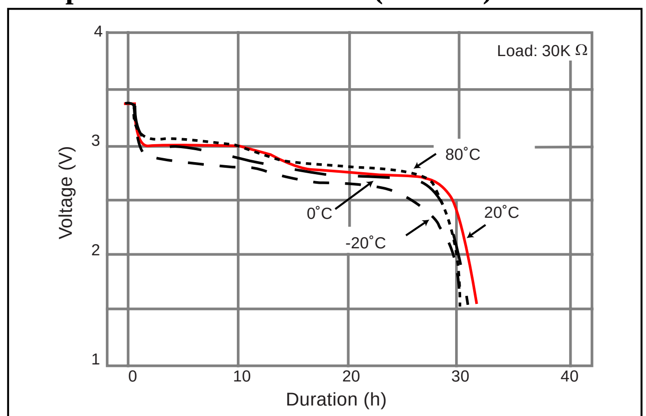
Overdischarge characteristics (VL2020)



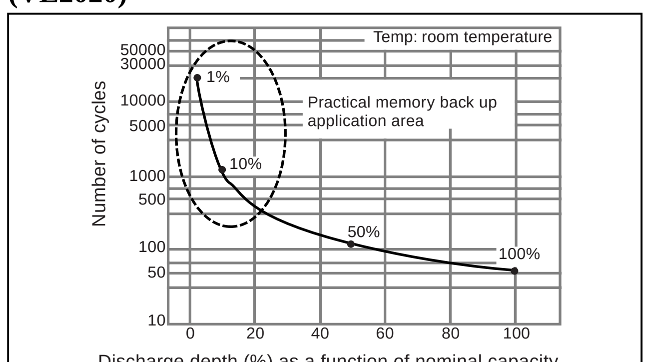
VL discharge characteristics



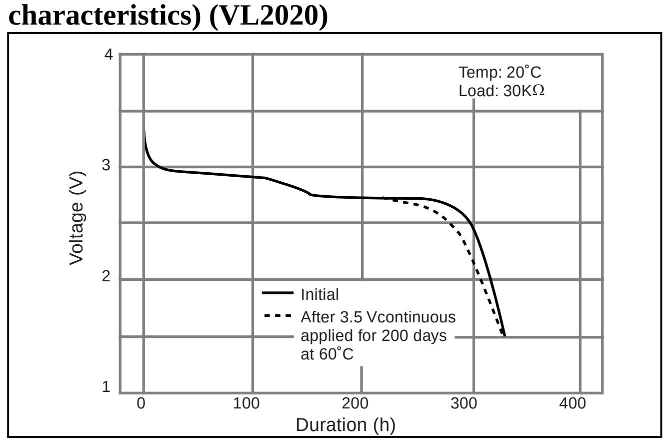
Temperature characteristics (VL2020)



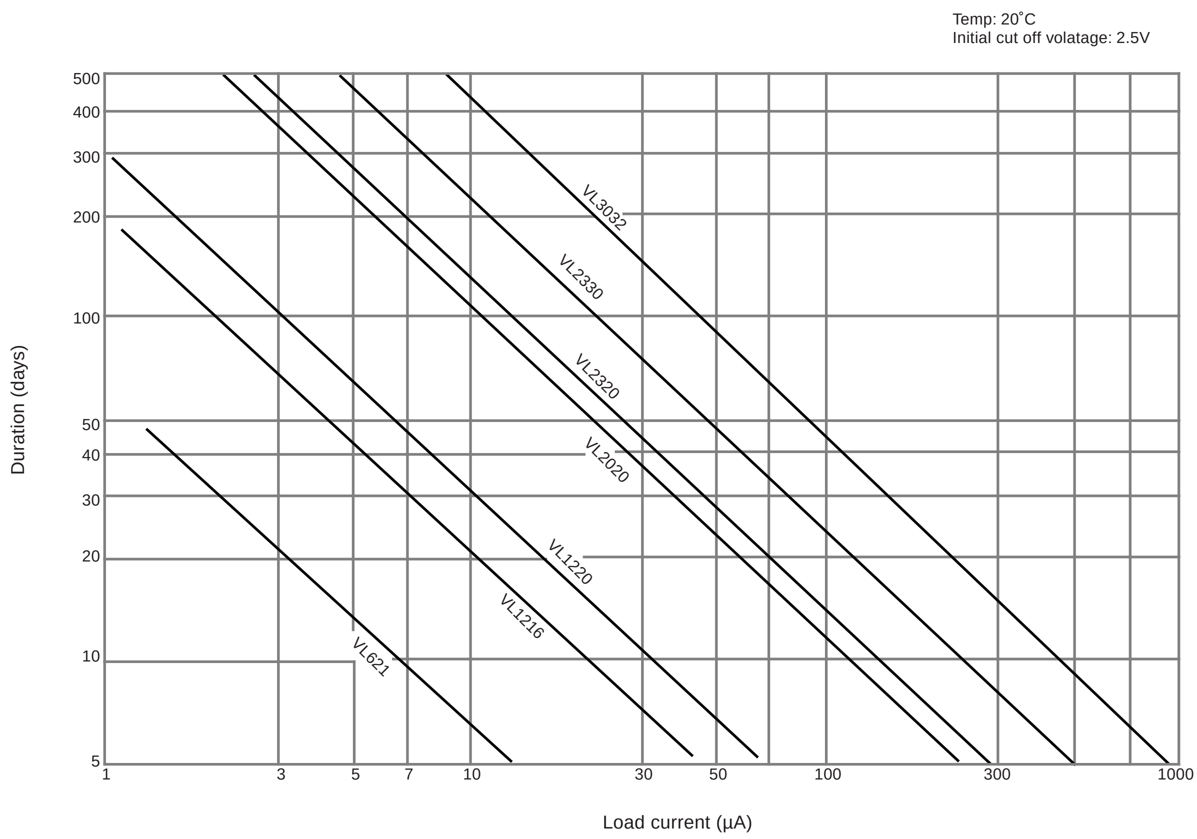
Charge/discharge characteristics vs. discharge depth (VL2020)



Withstand voltage characteristics (Overcharge characteristics) (VL2020)



Current drain as a function of duration



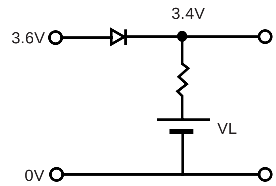
RECOMMENDED CHARGING CIRCUITS

Basic conditions: Fixed-voltage charging
Charge voltage: 3.4± 0.15 V
Current: at battery voltage 3 V

VL 621	approx. 0.2 mA or below
VL 1216,VL1220	approx. 0.5 mA or below
VL 2020	approx. 1.5 mA or below
VL 2320,VL2330	approx. 2.0 mA or below
VL 3032	approx. 4 mA or below

(Note: current can be increased when voltage is below 3 V.)

Charging circuits are important. Be sure to refer to "Precautions in handling "(page 61).



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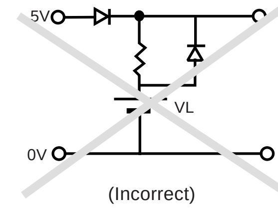
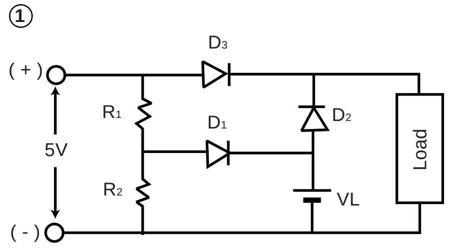


(Incorrect)
(Use caution in setting the charge voltage.)

Reference: Examples of 5-V charging circuits

①



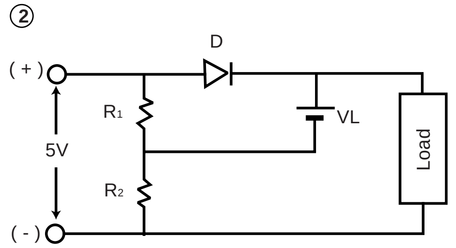
* Patent pending

Standard circuits

For D_2, select a diode of small inverse current (I_R = 1μA or below / 5 V)
D_1, D_2 = MA716 (Diode type code)
D_3 = MA704, MA700

	R_1	R_2
VL621	2.2kΩ	5.6kΩ
VL1220, VL1216	750Ω	2000Ω
VL2020	200Ω	510Ω
VL2320, VL2330	150Ω	390Ω
VL3032	68Ω	160Ω

②



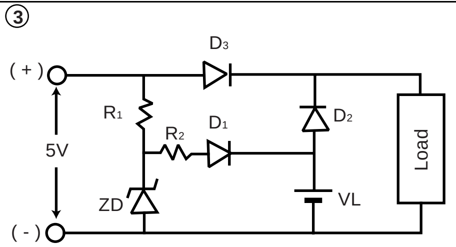
* Patent pending

Simple economical circuits

D: MA700 = (very small inverse current)

Load with 5 V applied	100μA to 10mA		100μA or below	
Vf of D	0.2v~0.6v		0~0.2V	
	R_1	R_2	R_1	R_2
VL621	8.2kΩ	2.4kΩ	6.8kΩ	2.7kΩ
VL1220, VL1216	2000Ω	510Ω	1500Ω	560Ω
VL2020	1300Ω	330Ω	470Ω	180Ω
VL2320, VL2330	1100Ω	270Ω	390Ω	150Ω
VL3032	510Ω	120Ω	180Ω	68Ω

③



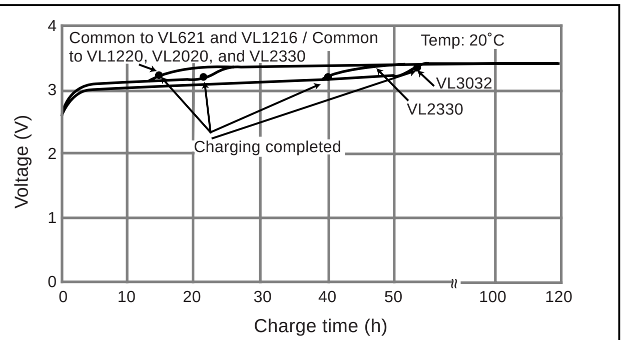
* Patent pending

	ZD	D_1	R_1	
A	MA3036L	MA704	300Ω	(common to all types)
B	MA3036H	MA700	270Ω	

Type		VL3032	VL2330	VL2320	VL2020	VL1220	VL1216	VL621
R_2	A	Not required				470Ω		1.5kΩ
	B	Not required				560Ω		1.6kΩ

For D_2, select a diode of small inverse current (I_R = 1μA or below /5 V)

Charging curve: circuits ① and ②



UL recognition conditions

When a protective component is shorted or opened, maximum charge current is regulated to the following value.

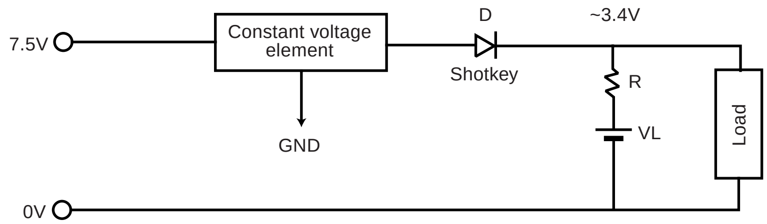
VL621	300mA
VL1216	300mA
VL1220	300mA
VL2020	300mA
VL2320	300mA
VL2330	300mA
VL3032	300mA

Call Panasonic for answers to specific questions about UL.

OTHER CHARGING CIRCUITS

Sample circuits

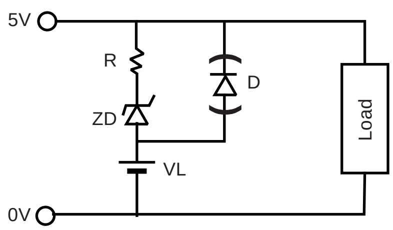
④For minimizing current leakage due to resistance, etc., In such a case as charging by another battery



REG.	D
3.7V	MA700

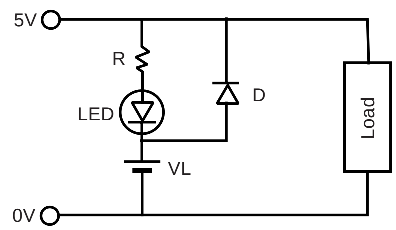
For the details, refer to the constant voltage element specifications

⑤Zener control



ZD = HZ2ALL
R - 43 ohm for VL 2320
68 ohm for VL2020
* D = MA700 or MA704

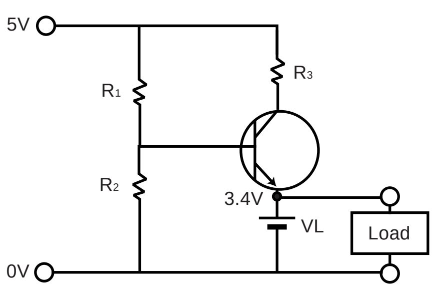
⑥ LED control



LED
R = 51 ohm for VL2320
* D = MA700 or MA704

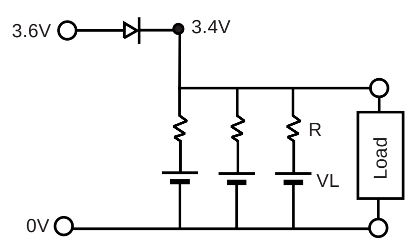
* Patent pending
* Select a diode having an inverse current as small as possible. (IR=1µA or below / 5 V)

⑦ Transistor control



(for VL2320)
R_1 = 4.3k Ω
R_2 = 15.0k Ω
R_3 = 680 Ω

⑧ Parallel circuit



(Note) Be sure to consult with us regarding the charge circuit to be used.

MANGANESE TITANIUM LITHIUM RECHARGEABLE BATTERIES (MT SERIES)

Overview

Manganese titanium lithium rechargeable batteries are compact rechargeable batteries developed for rechargeable watches, and backup power supplies for pagers and timers. The batteries employ lithium-manganese complex oxide as cathode material, and lithium-titanium oxide the (AB204) as the anode material. The batteries provide a capacity that is more than 10 times that of capacitors of the same size. Panasonic was the first company to introduce them (Note 1).

(Note 1: Press announcement on March 29,1995)

Features

- **Large capacity in a miniature size comparable to chip components**
  When fully charged, MT621 and MT920 are operable for about 1000 and 2500 hours respectively at a 1.2µA load.
- **Flat operating voltage**
  The operating voltage is comparatively flat in the range between 1.5 V and 1.2 V.
- **Superior charge characteristics**
  Charging efficiency is nearly 100% with small charging loss. The charge voltage can be set flexibly in the range between 1.6 V and 2.6 V.
- **Charging/discharging over a long period is possible.**
  More than 500 charging and discharging cycles to a discharge low limit voltage of 1 V (i.e. charge/ discharge of discharge depth 100%) is possible.
- **Excellent voltage and overdischarge withstanding characteristics**
  The batteries can withstand a continuous voltage application of 2.6V at a temperature as high as 60° and furthermore can withstand continuous over discharge at OV.
- **Small self discharge**
  The self discharge in 20 days at 60°C (equivalent to 1 year at normal temperature) is not more than approximately 10%.

Applications

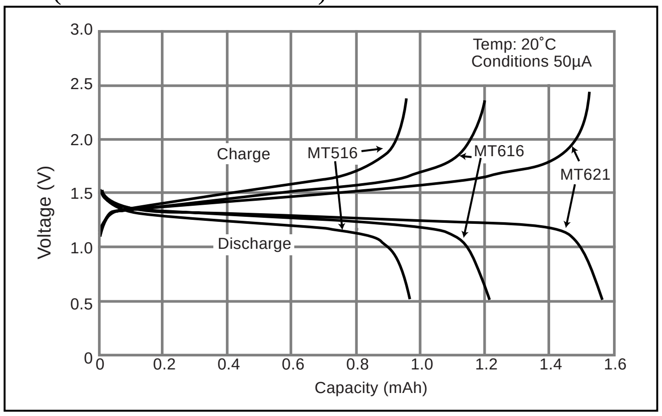
- Main power supply in compact products such as rechargeable watches
- Memory backup power supplies for pagers and timers

Specification Table

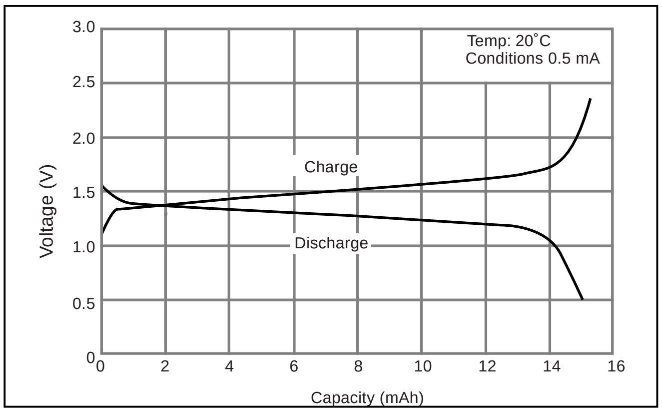
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
MT516	---	---	1.5	0.9	0.1	5.8	1.6	0.15
MT616	---	---	1.5	1.05	0.1	6.8	1.6	0.2
MT621	---	---	1.5	1.5	0.1	6.8	2.1	0.3
MT920	---	---	1.5	4.0	0.2	9.5	2.0	0.5
MT1620	---	---	1.5	14.0	0.5	16.0	2.0	1.3

*1 Nominal capacity shown above is based on standard drain and cut off voltage down to 1.0 V at 20°C

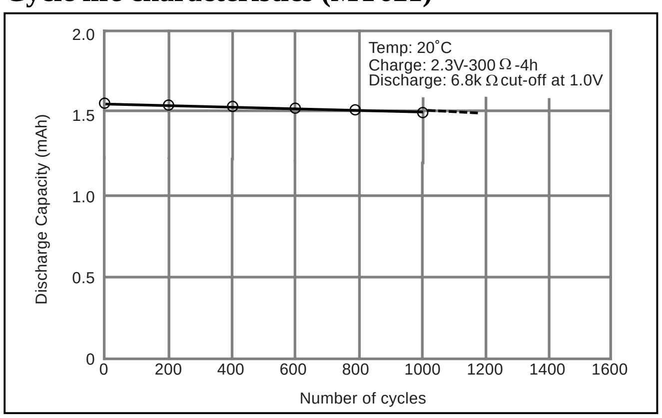
- Charge/discharge characteristics (MT516/MT616/MT621)



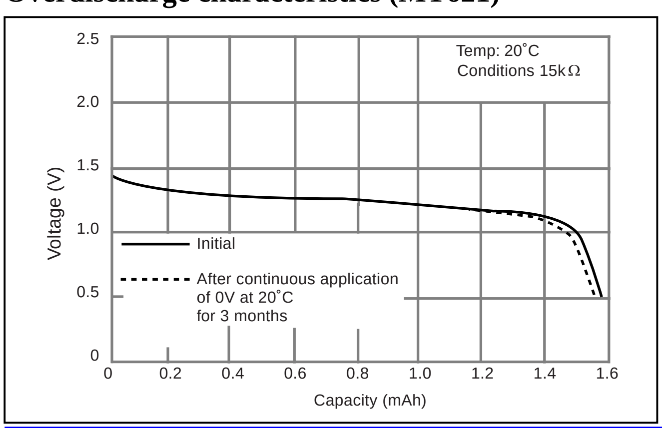
Charge/discharge characteristics (MT1620)



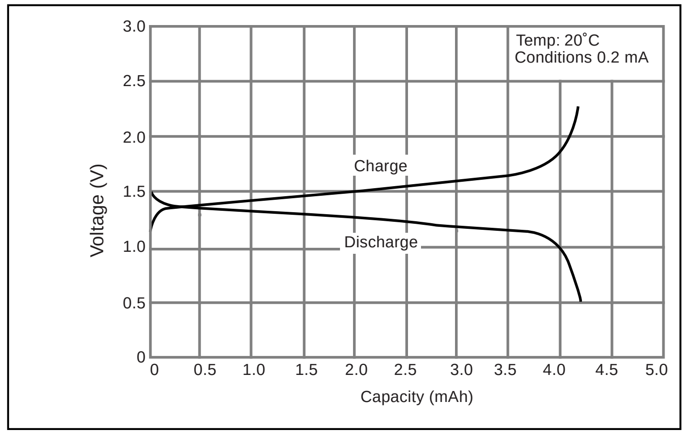
Cycle life characteristics (MT621)



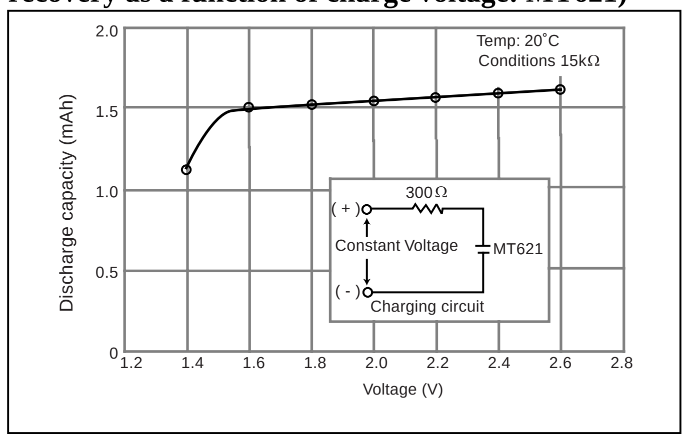
Overdischarge characteristics (MT621)



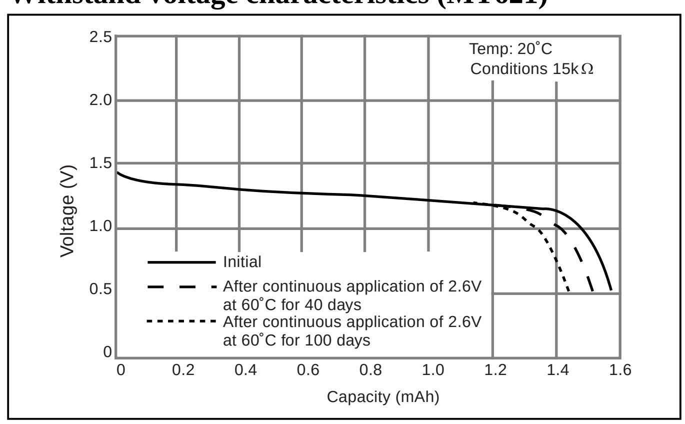
Charge/discharge characteristics (MT920)



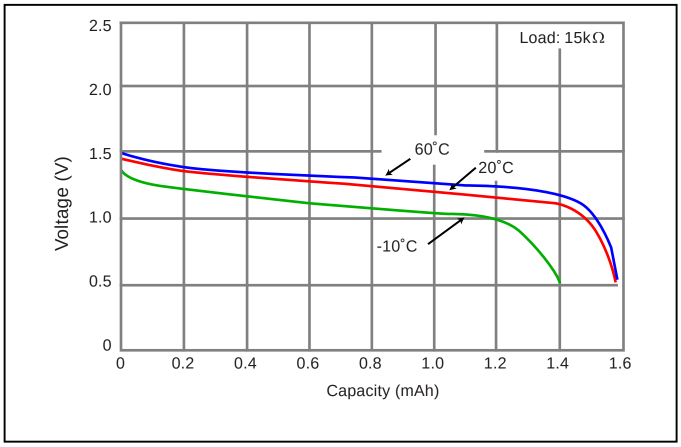
Constant voltage charging characteristics (Capacity recovery as a function of charge voltage: MT621)



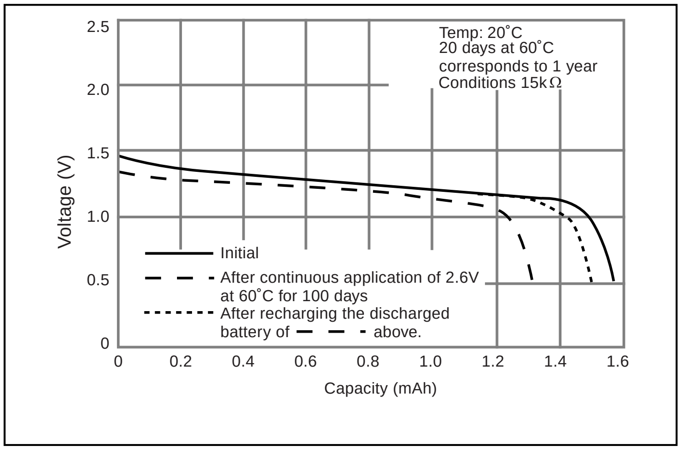
Withstand voltage characteristics (MT621)



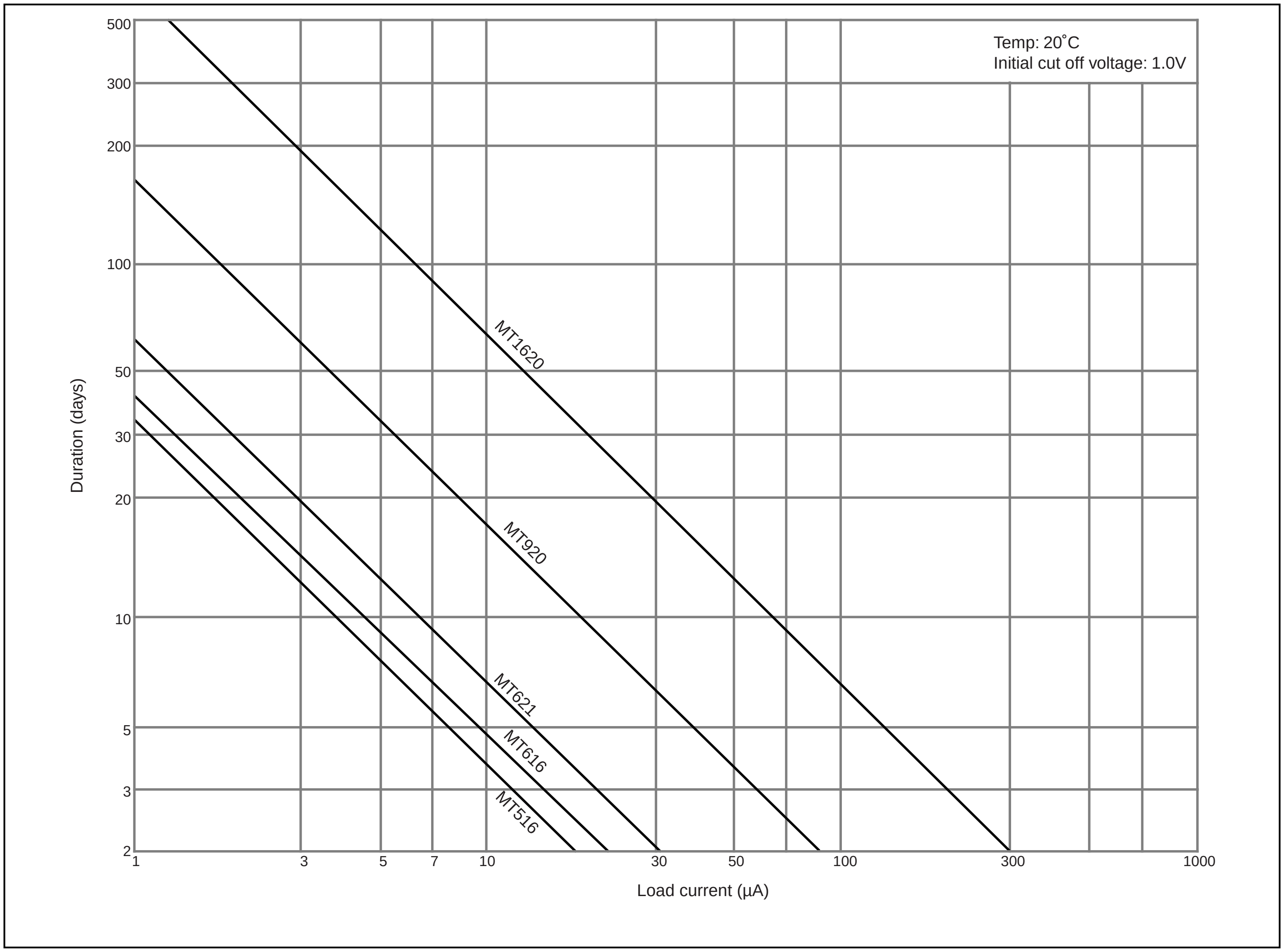
Discharge temperature characteristics (MT621)



Storage characteristics (MT621)



Current drain as a function of duration



MANGANESE LITHIUM RECHARGEABLE BATTERIES (ML SERIES)

Overview

These super-compact lithium secondary batteries feature a new configuration in which a manganese compound oxide is used for the positive electrode, a lithium/aluminum alloy for the negative electrode and a special nonaqueous solvent for the electrolyte. They can be charged at voltage levels of 3V or so, they have a large capacity and excellent overcharge and overdischarge withstanding characteristics. Their space-saving design enables them to be incorporated quite easily into 3V ICs.

Features

- **Charging at voltage levels even under 3V**
  In order to support the current trend in ICs toward lower voltages, these batteries can be charged at a 3 ± 0.2 voltage level, and this makes it easier to set the charging circuits for the circuits which employ 3V ICs.
- **Large capacity for hour-after-hour back-up**
  The ML621 has a nominal capacity of 3 mAh, and when the load is 5µA, it provides back-up for 600 hours after a full charge.
- **Excellent withstand voltage characteristics**
  These batteries can withstand the application of a continuous 3.2V voltage at a high temperature of 60°C.
- **Outstanding overcharge and overdischarge withstanding characteristics.**
  Even when these batteries have been left standing for a long time with no charge at all, their performance can be restored by recharging them.

Applications

Power source for backing up memory data in mobile telephones, personal handyphone systems, memory cards, pagers and other small-sized communications devices as well as in data terminals and office automation equipment.

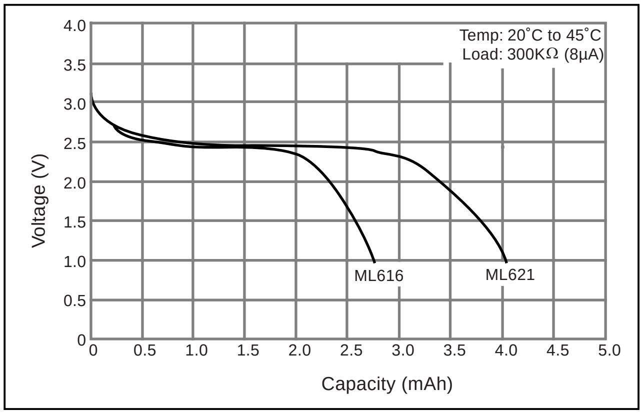
Specification Table

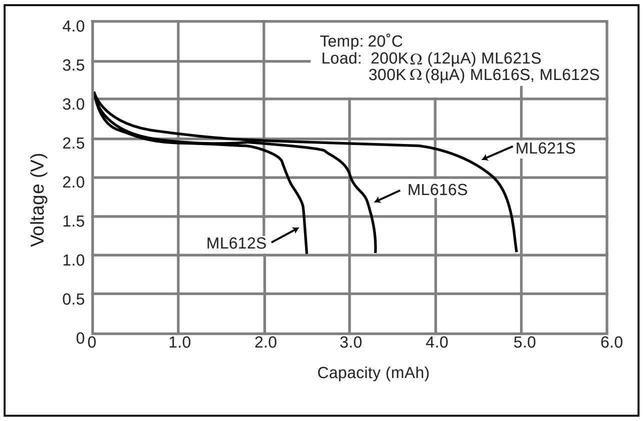
Model No.	JIS	IEC	Electrical characteristics 20°C			Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal *1 capacity (mAh)	Continuous drain Standard (mA)	Diameter (mm)	Height (mm)	
ML612S	---	---	3	2.3	0.01	6.8	1.2	0.15
ML616	---	---	3	2	0.01	6.8	1.6	0.2
ML616S	---	---	3	2.9	0.01	6.8	1.6	0.19
ML621	---	---	3	3	0.01	6.8	2.1	0.25
ML621S	---	---	3	4.5	0.01	6.8	2.1	0.23
ML2020	---	---	3	45	0.1	20.0	2.0	2.2

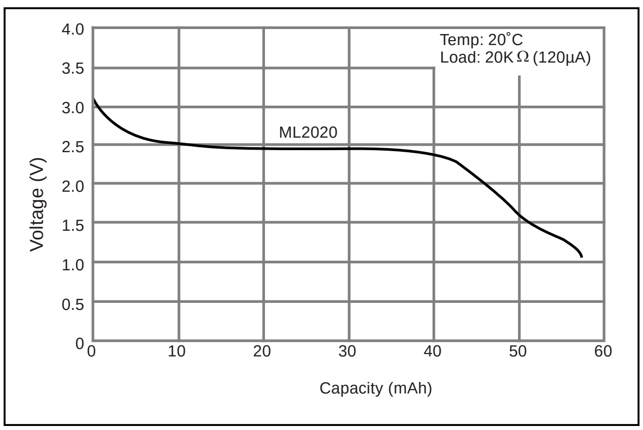
* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0 V at 20°C

Charge/discharge cycle	About 1,000 times at 10% discharge depth to nominal capacity
Charge	Constant-voltage charging (refer to recommended charging circuit)
Operating temperature	-20°C to 60°C

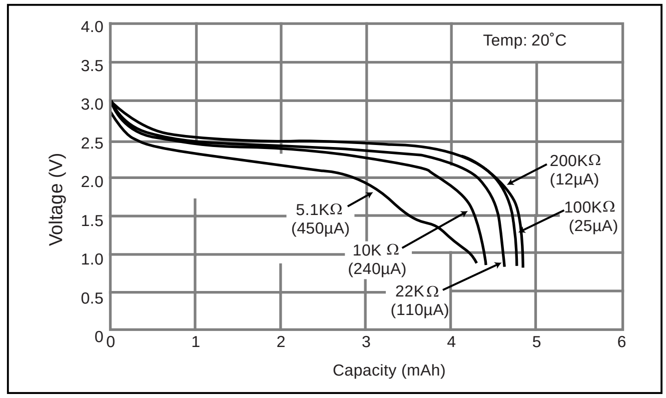
Discharge characteristics



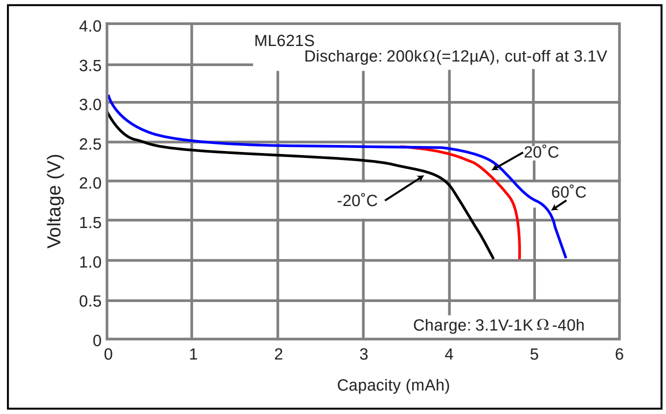




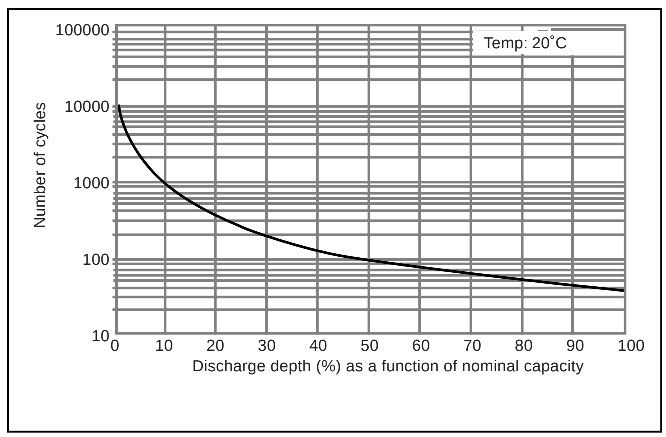
Discharge load characteristics (ML621S)



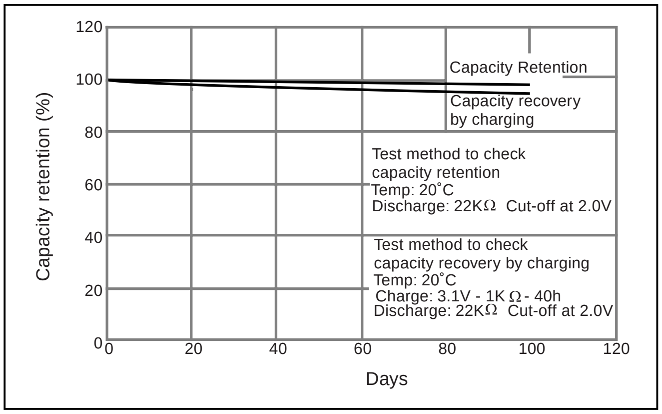
Discharge temperature characteristics (ML621S)



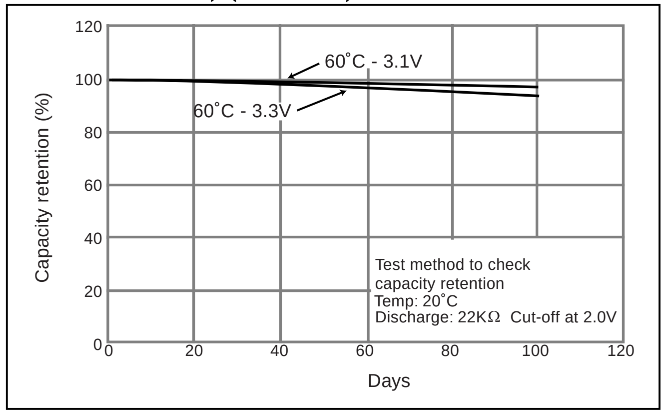
Charge/discharge characteristics vs. discharge depth (ML621S)



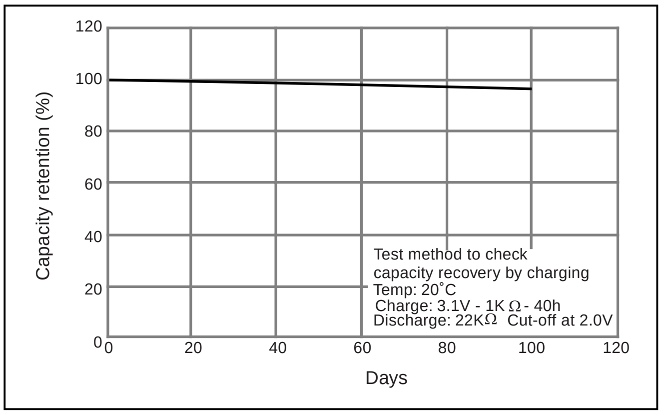
Storage characteristics (ML621S)



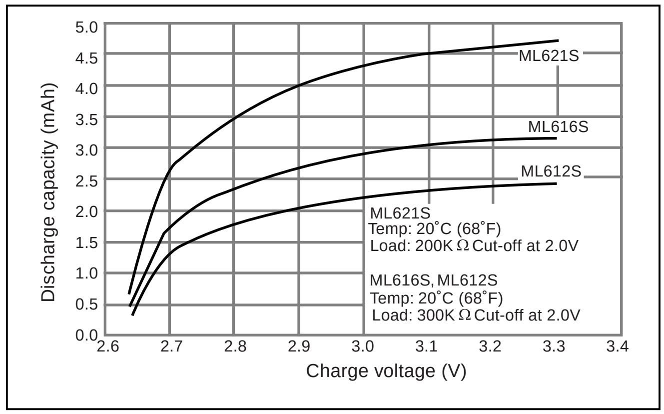
Withstand voltage characteristics (Overcharge characteristics) (ML621S)



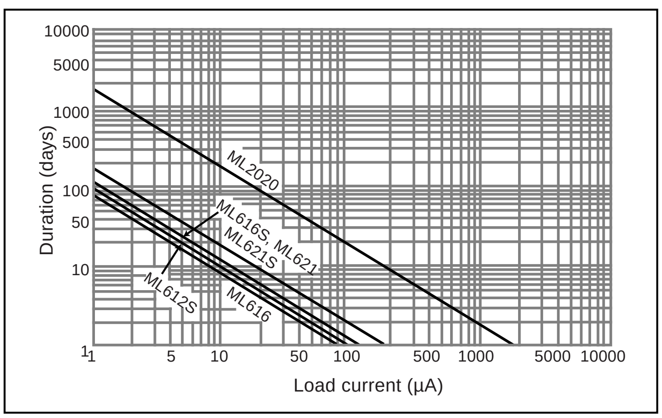
Overdischarge withstanding characteristics (ML621S)



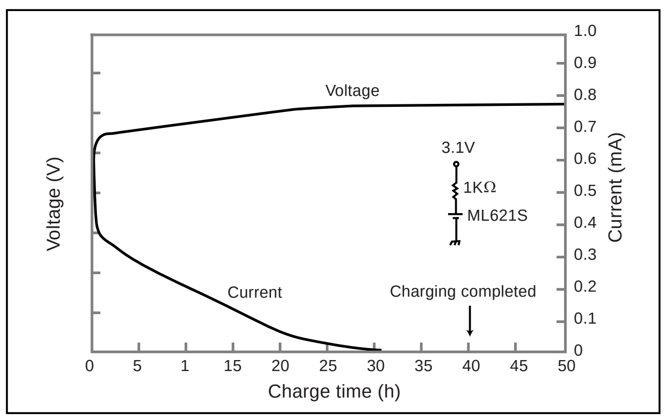
Relationship between charging voltage and charge acceptance



Relationship between current consumption and charge retention time



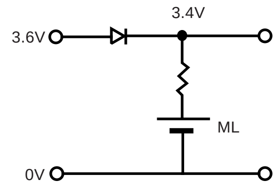
Constant-voltage charging characteristics (ML621S)



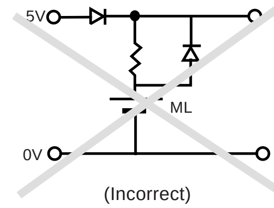
RECOMMENDED CHARGING CIRCUIT

The choice of the charging circuit is extremely critical if full rein is to be given to the battery characteristics. Make every effort to ensure that the proper charging circuit is used; otherwise, trouble may result.

Basic conditions: Constant-voltage charging
Charging voltage: 2.8 to 3.2V (Standard voltage: 3.1V)
Current: (0.3mA for ML616. ML621 with 2.5V battery Voltage)



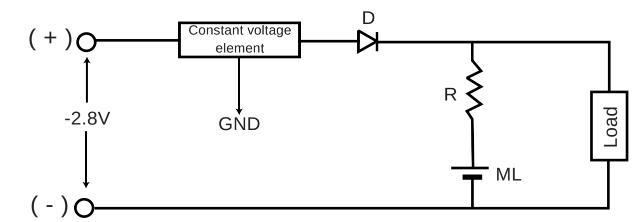
(Correct)



(Incorrect)

(Use caution in setting the charge voltage.)

①



When charging using another battery

ML612S, ML616, ML616S, ML621

REG	D	R
3.2V	MA700	1.8KΩ
3.1V	MA700	1.5KΩ

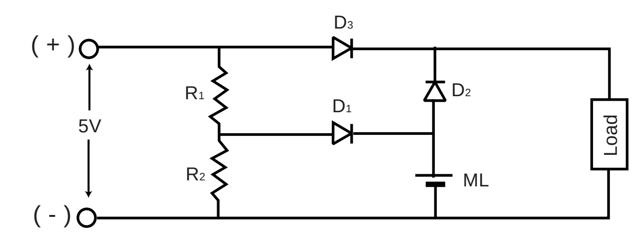
ML621S

REG	D	R
3.2V	MA700	910Ω
3.1V	MA700	750Ω

ML2020

REG	D	R
3.2V	MA700	180Ω
3.1V	MA700	150Ω

②



Standard circuit

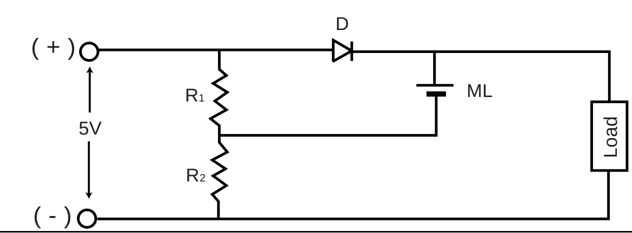
- Select a diode with a low reverse current for D2.

(I_R=1µA/5V)

D1, D2: MA716
D3: MA704, MA700

	R_1	R_2
ML612S, ML616 ML616S, ML621	2.7KΩ	5.1KΩ
ML621S	1.1KΩ	2.0KΩ
ML2020	180Ω	330Ω

③



Simple circuit which can be configured at low cost

Load with 5V applied	100µA	
VF of D	0~0.2V	
	R_1	R_2
ML616 ML621	5.1KΩ	2.7KΩ

* VF of D will be different from the value given above if a current in excess of 100µA flows to the load during operation. Compensation must be provided by the resistors in such cases.

UL Recognition

UL recognition for the ML621 and ML616 was received in April 1997.

In filling application for UL recognition, a maximum value of 300mA was given as the condition restricting the current when a short-circuit or open-circuit situation occurs.

When a protective component is shorted or opened, maximum charge current is regulated to the following values:

ML616	300mA
ML621	300mA
ML2020	300mA

Call Panasonic for answers to specific questions about UL.

Precautions for handling rechargeable coin type lithium batteries

Please observe the following precautions to keep the batteries in good condition.

Precautions for storage

- Avoid storing batteries at unusually high temperatures.
- Store batteries in a low-humidity location with little temperature variation. If batteries are stored in humid areas, moisture may condense on their surface, exerting an adverse influence on their electrical characteristics.
- Store batteries away from direct sunlight.

Precautions in handling

- For measuring the battery voltage, use an instrument with a resistance of 10 MΩ or higher.
- The operating temperature range of batteries is from -20°C to 60°C. When batteries are used or stored for a long time at 60°C or higher temperatures, their performance may deteriorate. Consult Panasonic if batteries are to be used at temperatures above 60°C.
- Do not use batteries with their (+) and (-) electrodes reversed; this incorrect use deteriorates battery performance and may cause corrosion of the (-) terminal (anode cap) during charging, leading to leakage of battery solution.
- Absolutely avoid mixed use of the batteries and other primary or rechargeable batteries. Also avoid mixed use of batteries with different sizes even if they belong to the same series, and avoid mixed use of new and used batteries. Performance differences among different batteries may damage equipment.
- When mounting terminal-attached batteries onto a printed circuit board, etc., by dipping in a solder bath, limit the dipping time to a maximum of 5 seconds: dipping for a longer time may cause an adverse influence on the electrical characteristics such as voltage and capacity. Use extreme caution not to drop batteries into the solder bath during dipping; if dropped into the solder tank, batteries may burst due to abrupt heating. Do not apply solder directly to batteries. Also, do not use reflow soldering.
  * For details, refer to "Guide to correct soldering of lithium batteries with terminals" on page 94.
- Do not insert batteries into antistatic materials or wrap the battery-mounted PC board in conductive sheets. These materials can cause a voltage drop or drain the batteries.
  * For details, refer to "Use caution with antistatic conductive materials" on page 96.
- Do not place two or more batteries together into a bag or container; external shorting between batteries may cause a voltage drop or drain the batteries.
  * For details, refer to "Use caution in allowing batteries to contact each other" on page 97.

Precautions in equipment design

Common precautions for vanadium pentoxide, manganese titanium lithium and manganese lithium rechargeable batteries

- Do not mount batteries in a high-temperature or heat-generating location; protect batteries from foreign materials.
- If lead wires and connection terminals like tab terminals are needed for the batteries, Panasonic can supply external terminals (connectors, etc.) on request.
- Please be sure to consult Panasonic when two or more batteries are to be used in series or in parallel; special circuit design is required.
- Take into account during design that the internal resistance of batteries increases as they approach the end of service life.

Vanadium pentoxide lithium rechargeable batteries

- When constant-voltage charging, observe the specified range of charge voltage. If the charge voltage is above the upper limit, the internal resistance of batteries may increase, causing battery performance to deteriorate; if charge voltage is below the lower limit, battery capacity cannot recover completely. If the charge voltage exceeds approximately 4 V, the (+) terminal (case) may become corroded, causing leakage of the solution.
  * For details, refer to "Influence of charge voltage of vanadium pentoxide lithium rechargeable batteries" on page 99. When using fixed-current charging, call Panasonic for consultation.

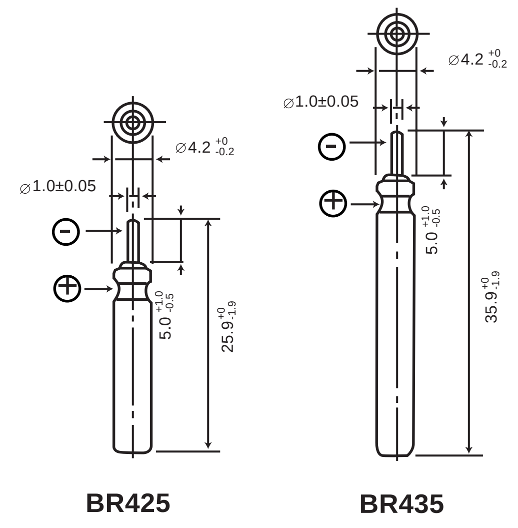
Manganese titanium lithium rechargeable batteries

- For the charging circuit of manganese titanium rechargeable batteries, please be sure to consult us.
- Give careful thought to the contact design as weak electrical contact may cause defective operation of the batteries.

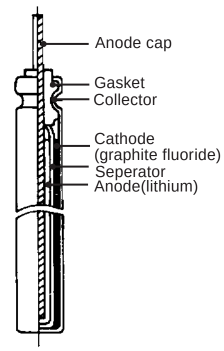
Manganese Lithium rechargeable batteries

- Restrictions on the charging voltage range apply in exactly the same way as for Vanadium pentoxide rechargeable batteries.
- For the charging circuit of manganese lithium rechargeable batteries, please be sure to consult us.

Dimensions (mm)



Cutaway view



Overview

Pin type lithium batteries were first introduced by Panasonic. The predominant use of pin type batteries has been as the power supply for LED night fishing floats.

Features

- **Voltage as high as 3 V, about twice that of dry batteries**
  The nominal voltage is 3 V, about twice that of manganese and alkaline button batteries. A single pin type lithium battery can light an LED.
- **Unique slim pin shape**
  They are slim, high energy-density batteries contained in an aluminum casing.

Applications

- LED night fishing floats
- Fishing pole tip lights
- Various illuminations
- Toys

Specification Table

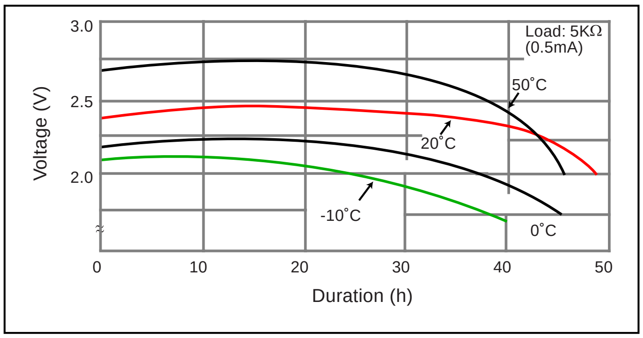
Model No.	JIS	IEC	Electrical characteristics 20°C				Dimensions (Max.)		Approx. weight (g)
			Nominal voltage (V)	Nominal capacity (mAh) [*1]	Continuous drain		Diameter (mm)	Height (mm)	
					Maximum (mA)	Standard (mA)			
BR425	---	---	3	25	4	0.5	4.2	25.9	0.55
BR435	---	---	3	50	6	1	4.2	35.9	0.85

* 1 Nominal capacity shown above is based on standard drain and cut off voltage down to 2.5 V at 20°C

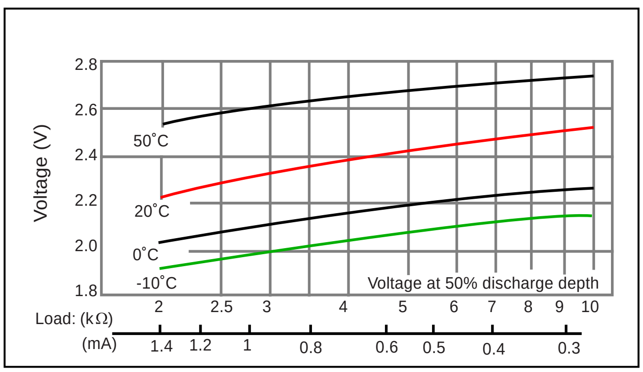
Individual data sheets

BR425

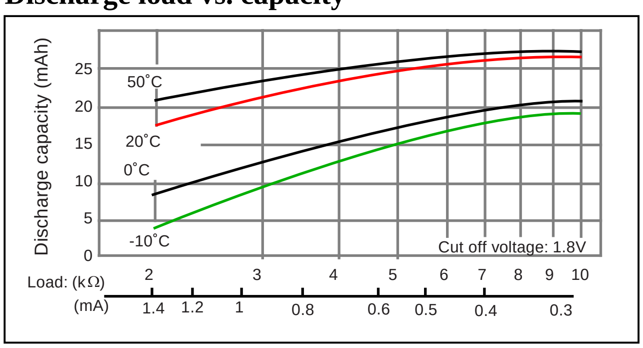
Discharge temperature characteristics



Discharge load vs. operating voltage

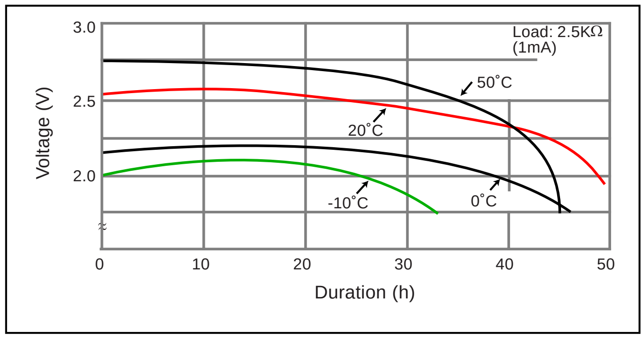


Discharge load vs. capacity

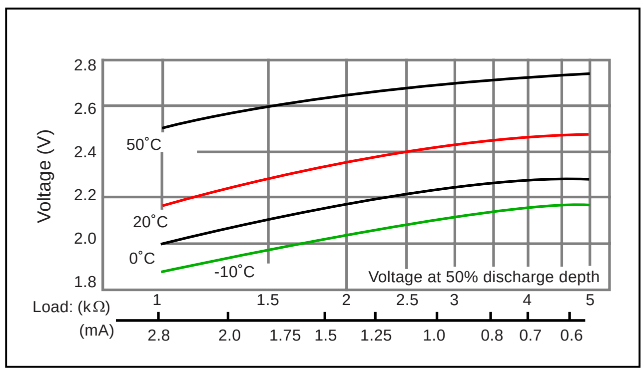


BR435

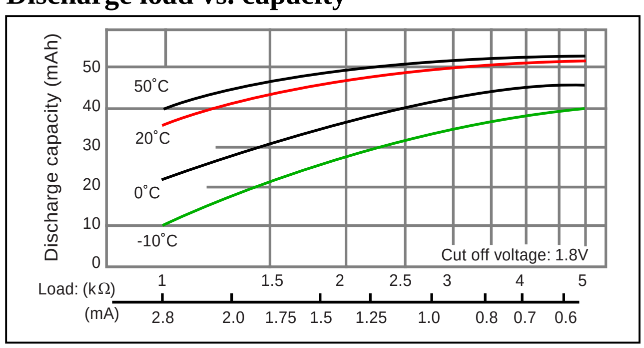
Discharge temperature characteristics



Discharge load vs. operating voltage



Discharge load vs. capacity

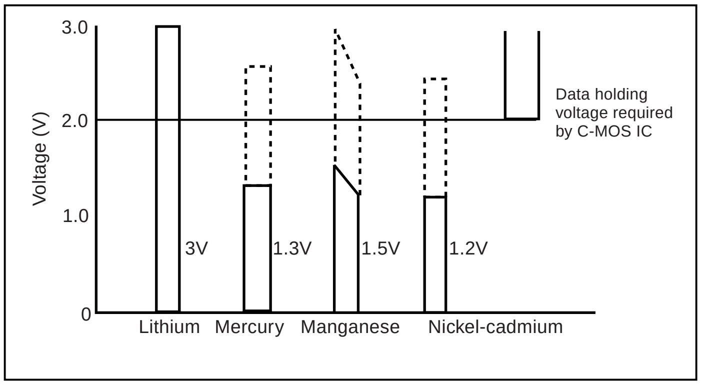


Overview

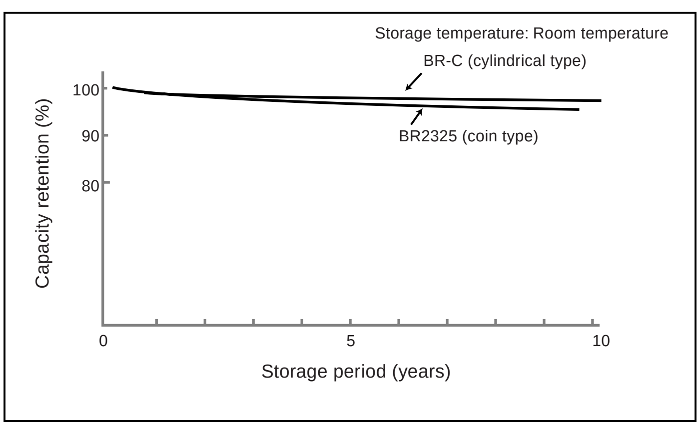
In recent years, rapid progress in the capabilities and performance of electronic devices has been accompanied by great advances in digitization. With this trend, it has become customary to use batteries as a backup resource for semiconductor circuits.
Until recently, primary batteries such as manganese batteries, mercury batteries and silver oxide batteries, or secondary batteries such as nickel cadmium batteries have been used for this purpose. These batteries, however, require replacement every four to five years at best; and even on a yearly basis in some cases. These limitations demand constant vigilance by the users of the devices, and are unsatisfactory as a backup for vital functions. There are also considerable limitations in operation, storage temperature range and application. In contrast, lithium batteries combine long-term reliability of over 10 years and a wide range of operating temperatures, neither of which is possible with conventional batteries.
These advantages make it possible to simplify the circuit and structure of devices by adopting batteries with terminals which can be soldered to the printed board like other electronic components, thereby matching the operating functionality of batteries to the life span of devices. Thus, lithium batteries are suitable in backup systems for the memory of C-MOS, RAM and IC's of microcomputers, and calendar/clock circuits.
Panasonic meets new design demands with a diversified product lineup including newly introduced rechargeable vanadium pentoxide lithium rechargeable batteries and Manganese titanium lithium rechargeable batteries.

FEATURES

- **High voltage**
  The high energy density of lithium batteries is of particular importance for miniaturized equipment. This single battery, by providing approximately 3 V, can replace two or three conventional batteries. The following chart shows the number of cells for each series of batteries required to provide the C-MOS IC data holding voltage.

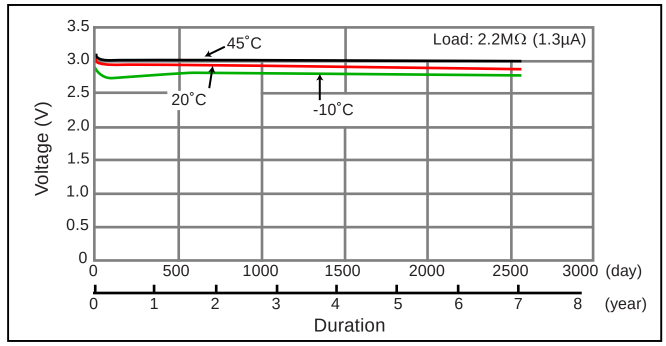


- **Superior storability**
  Because lithium batteries employ substances that are very chemically stable as the cathode active material (BR series: poly carbonmonofluoride; CR series: manganese dioxide), storage life is more than five times greater than that of conventional batteries, with more than 90%residual capacity after 10 years of storage.
  The estimated rate of annual deterioration is around 0.5%for the cylindrical type BR series (poly carbonmonofluoride lithium batteries), and around 1% for the cylindrical type CR series (manganese dioxide lithium batteries) and the coin type BR and CR series.

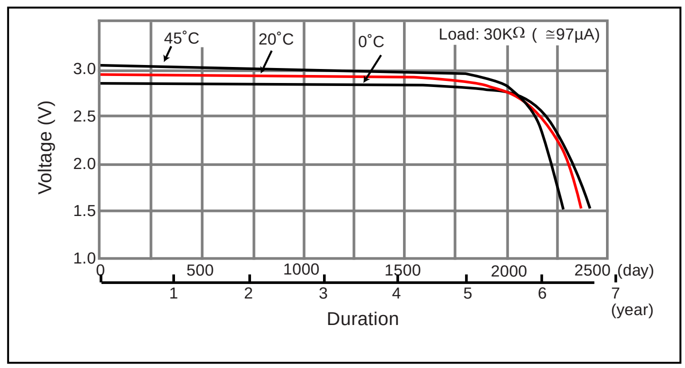


- **Long term discharge**
  A sustained, stable voltage for a long period (up to 6 years) under high-impedance discharge (BR2325: 2.2 MΩ; BR-C: 30 MΩ) has been verified at all operating temperatures.

BR2325



BR-C

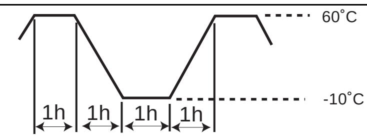
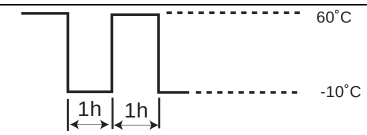


FEATURES – CONTINUED

- **Superior environmental resistance**

Because lithium batteries employ organic electrolytes with minimal creeping, they are vastly superior in leakage resistance under environmental changes compared to batteries that employ aqueous electrolytes. The batteries provide stable characteristics under high temperature and humidity conditions (45°C- 90% RH; 60°C-90% RH) and even under severe heat shock.

Leakage resistance evaluation items

Item	Test
High-temperature storage	60°C
High-temperature High-humidity storage	45°C – 90%RH 60°C – 90%RH
Temperature cycle	
Heat shock	

Leakage resistance test results

Model \ Conditions Storage	60°C		45°C · 90%		60°C · 90%		Temperature cycle	Heat shock
	1 month	3 months	1 month	3 months	1 month	3 months	60 cycle	120 cycle
BR2325	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
BR-2/3A	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗

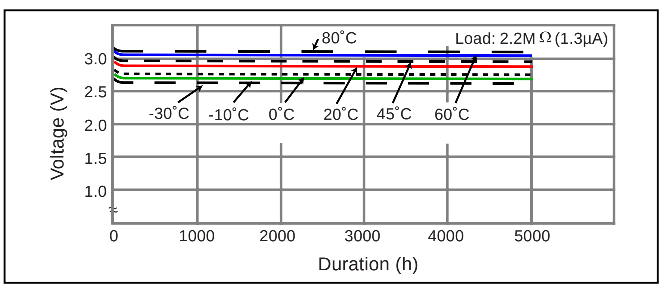
⊗: Good Performance

Wide operating temperature range

Because lithium batteries employ organic electrolytes with a solidifying point that is much lower than the aqueous solution type electrolytes used in other types of batteries, they operate in low-temperature regions. Generally, the operating temperature range for all lithium batteries is -20°C to 60°C.

In cases where the operating current is small or a wider range of operating voltage is acceptable, BR series coin type batteries, some CR series coin type, and BR series cylindrical type batteries can be used between -40°C to +85°C, respectively.

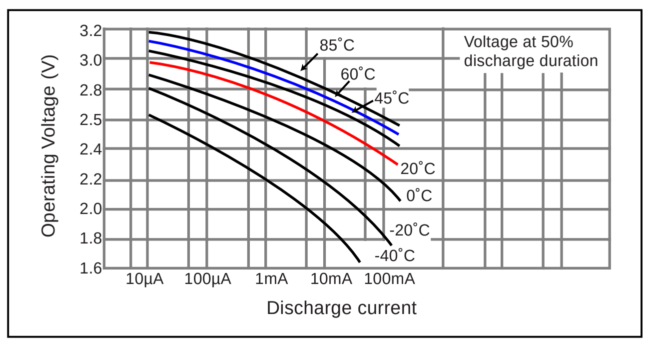
Operating voltage under high-resistance discharge: BR2325



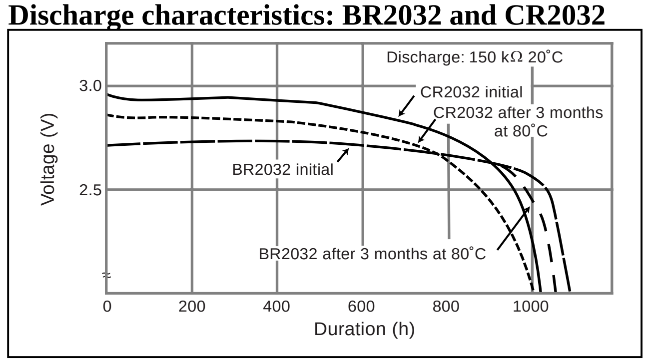
- **Difference between BR series (poly carbonmono-fluoride lithium batteries) and CR series (manga-nese dioxide lithium batteries)**

Characteristically, CR batteries provide a slightly higher voltage than BR batteries during the first half of discharge. BR batteries, compared with CR batteries, show more stable characteristics with less voltage variation during the last half of discharge. As for storage characteristics, BR batteries perform better at higher temperatures. These characteristics should be taken into consideration when selecting a battery for each application.

Operating voltage vs. current drain: BR-2/3A



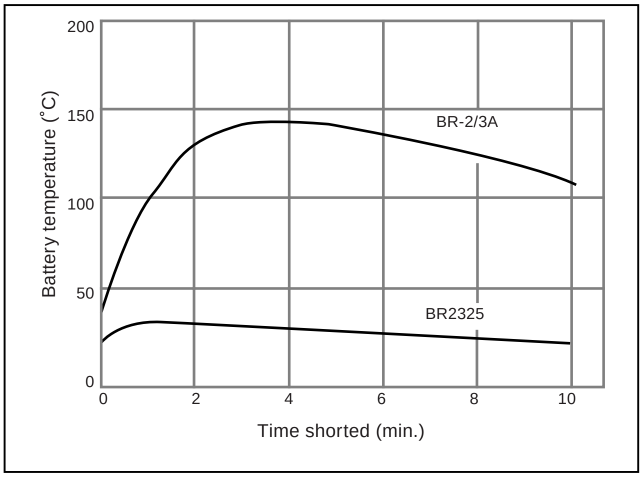
Discharge characteristics: BR2032 and CR2032



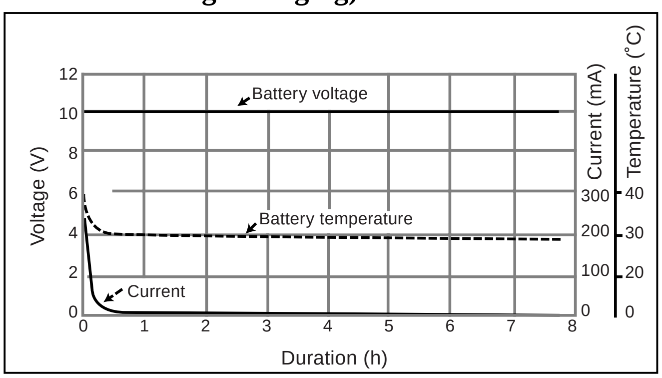
- **Superior safety**
  Poly carbonmonofluoride lithium batteries do not employ any harmful or corrosive liquids or gases for the active materials, assuring a construction that provides for exceptional safety. This superior safety level has been confirmed by repeated testing. Result: Panasonic lithium batteries have been recognized as meeting the UL safety standard (UL1642).

(1) The increase in battery temperature when continuously shorted is shown by the following graph.

Battery surface temperature when short-circuited



Charge resistance characteristics of BR2325 (10 V consistent-voltage charging)

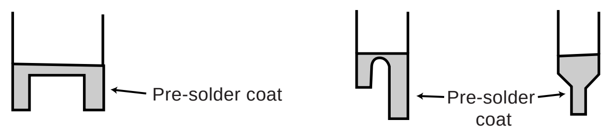


(2) Destruction of the charge-preventive diode.
It is anticipated that the power supply voltage is directly applied to the batteries. In this case, a large current will flow to the battery initially, but the current will diminish rapidly, with no fear of safety trouble. (Coin type)
However, disintegration of the electrolyte, etc. may occur in the battery, causing an increase in impedance, resulting in the significant deterioration of battery performance. Therefore, consideration should be given to the circuit design for preventing primary batteries from being charged.

- **Reliable terminal welding**

(1) Terminal welding with laser.
The company employs a laser for welding the terminals of the batteries that can be mounted on the printed board by soldering. Whereas the tensile welding strength obtained from the conventional resistance welding method is 20 to 50 N (approx. 2 to 5 kgf), laser welding increases the strength to about 10 kg and reduces the variation to about a half. It also makes it possible to perform terminal welding to a battery as thin as 1.6mm. With the laser, a highly reliable terminal welding method has been established, providing wide applicability without the need for reinforcement.

(2) Pre-solder-coated terminal tips.
Terminal tips are pre-solder-coated to increase the soldering reliability



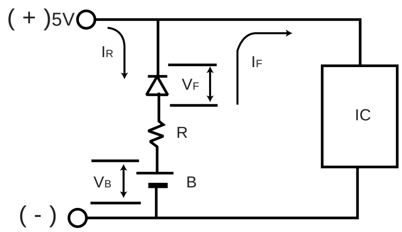
POINTS OF IC MEMORY BACKUP DESIGN

(1) Battery selection

When selecting a battery, give consideration to such factors as current consumption of the equipment to be used, expected life of the battery, and environmental temperatures. At low environmental temperatures, current consumption of the IC becomes smaller but the discharge voltage of batteries also decreases. At high environmental temperatures, the capacity deterioration of batteries in long-term use becomes significant. The relationship between current consumption and duration years of the battery used in normal temperature environment is shown on the graphs in pages 28 and 51.

(2) Backup voltage condition

A typical memory backup circuit is illustrated below. Memory holding voltage is expressed as: (H_8-V_F- I_F X R) is greater than (Memory holding voltage of IC).



(3) Inverse current blocking diode

Since lithium primary batteries are not rechargeable, use of an inverse current blocking diode and a protective resistor in series is required where there is the possibility of charging in the equipment circuit. (Refer to UL recognition on page 70.) Use a silicone diode or schottky diode of small inverse current for preventing inverse current. To maintain the characteristics of coin type lithium batteries, the total charging amount of a battery during its total usage period must be no greater than 3% of the nominal capacity of said battery. For example, assuming the use of CR2477 (l000mAh) in a memory backup power supply for 5 years, charging by a leakage current of the inverse current blocking diode should be no greater than 30mAh (=3% of l000mAh), thus:

30mAh / Total usage period

(5 years x 365 days x 24 hours) = 0.7µA; that is, an inverse current blocking diode of which the inverse current is not greater than 0.7µA should be selected.

Allowable total charging capacity:

For coin type batteries: Within 3 %
For cylindrical type batteries: Within 1 %

Note that the inverse current of inverse current blocking diodes varies with temperature.

(4) Protective resistor

For UL Standard applied products, a resistor must be used in series with the battery to limit the charge current which will flow to the battery in case of destruction in continuity of the inverse current blocking diode. The maximum allowable current is specified for each battery size, and the resistance value of resistors is determined as: R is greater than V / I (I = Maximum allowable charge current specified by UL) This circuit is also recommended for non-UL applied devices.

(5) Battery terminal soldering

When mounting batteries onto circuits, do not directly solder to the batteries; use batteries with terminals. Observe the following instructions for soldering batteries with terminals.

Never use reflow soldering

In reflow soldering, the battery body is directly heated to a high temperature, causing solution leakage; deterioration of battery characteristics; or danger of rupture or ignition.

Soldering with a soldering iron

Take care not to touch the battery directly with the soldering iron. Maintain an iron tip temperature at 350°C; perform soldering quickly (within 5 seconds).

Automatic dip soldering

Do not allow the temperature of the battery body to exceed 85°C. Be alert to possible temperature rise of the battery body after dipping due to ambient heat in the dipping device. The basic conditions should be: Solder dipping bath temperature of up to 260°C, dipping time of within 5 seconds, a maximum of two times.

(6) Cleaning and drying

Make sure to use a non-conductive cleaning solution. In a conductive solution, batteries may discharge, causing a deterioration of battery performance such as voltage drop. Dry batteries at a temperature below 85°C. If the temperature of the battery body exceeds 85°C, the gasket may be deformed by heat, causing solution leakage or deterioration of battery performance.

(7) Battery location

Place batteries far from heat-generating components. When located close to them, batteries may absorb heat, causing deformation of the gasket, leading to solution leakage or deterioration of battery performance.

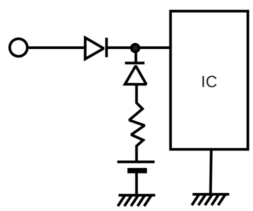
(8) Battery storage

Keep batteries away from direct sunlight. Store batteries in a dry place with minor temperature variation. Do not store batteries in a high-temperature, high-humidity area, where deterioration of the battery may occur.

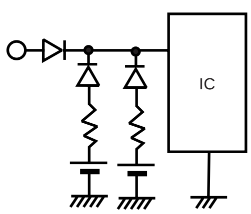
(9) Others

- Be careful not to allow any current leakage from the wiring to flow to batteries.
- Keep batteries away from high-temperature, heat-generating locations.

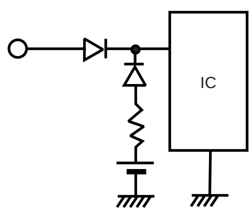
1. Two-cell 6 V use



2. Parallel use



3. UL condition (B): Protective resistor inserted



		CR1220	3
		CR1216	3
		CR1212	2
		CR1025	2
Pin type	(CF)n/Li	BR435	0.2
		BR425	0.1

RECOGNITION

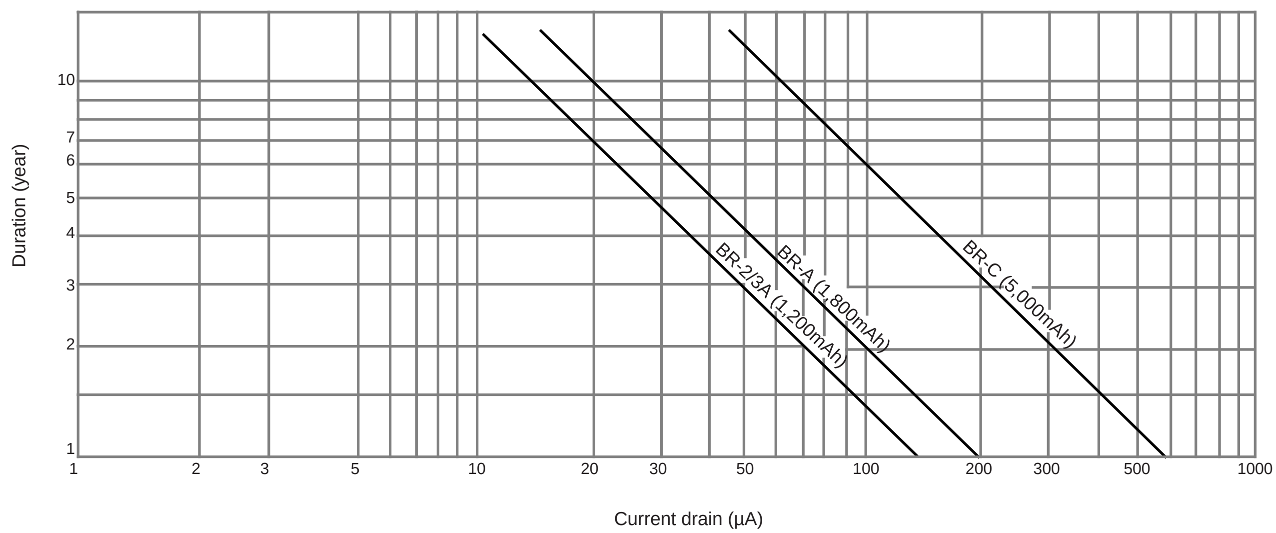
Panasonic lithium batteries hold UL recognition as follows: (As of March 1998)
File No. MH12210
Type
BR-C, BR-A, BR-AH, BR-AG, BR-2/3A, BR-2/3AH
BR-2/3AG, BR-2/3AA, BR-1/2A, BR-E2
BR-E3, BR-P2, CR2, CR-P2, 2CR5, CR123A
BR3032, BR2330, BR2330A, BR2325, BR2320
BR2032. BR2477A, BR2020, BR2016, BR1632
BR1632A, BR1616, BR1225, BR1225A, BR1220
BR1216, BR435, BR425
CR3032, CR2477, CR2412, CR2354, CR2330, CR2320
CR2032, CR2025, CR2016, CR2012, CRl632, CR1620
CRl616, CR1612, CR1220, CR1216, CR1212, CR1025
VL3032, VL2330, VL2320, VL2020, VL1220, VL1216
VL621
ML2020, ML621, ML616

In the use of lithium batteries, the conditions stated below must be satisfied. For details, consult Panasonic
Condition 1. A protective resistor should be inserted in series to the battery for protecting the battery from the charge current in case of conductive destruction of the diode. Protective resistance value must be decided so that the charge current expected when the diode is destroyed is below the values specified in the table to the right.
Condition 2. Replacement of lithium batteries should be carried out by trained technicians since the batteries are intended as integral components for a device's circuit. Lithium batteries, except for * marked models in the table on the right, are user replaceable as far as certain conditions are met. Contact us for details.
Condition 3. Lithium batteries should be used at ordinary temperatures not exceeding 100°C.
Models BRl225A and BR1632A should be used at ordinary temperatures not exceeding 150°C.
Condition 4. The number of batteries to be used in series should be four, at the maximum. They must all be replaced at the same time. The current through the batteries should be no greater than the current allowable for the number of batteries in the series.
Condition 5. Vanadium pentoxide lithium rechargeable batteries should be charged with a current no greater than 300 mA.

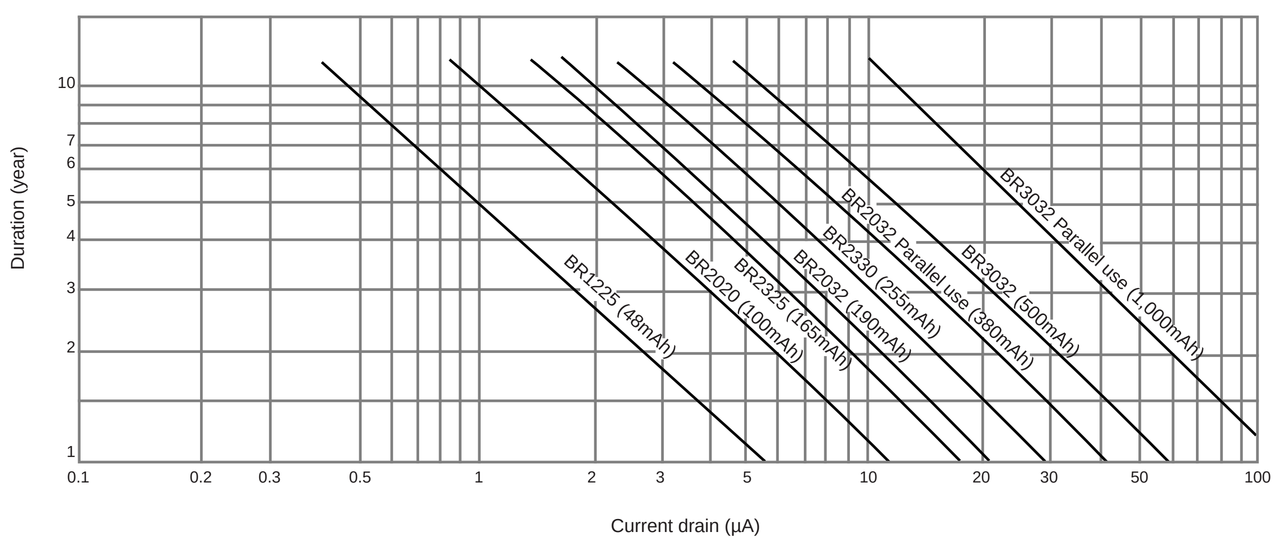
Current drain vs. Duration

Temp: 20˚C
Initial cut off voltage: 2.0V

Cylindrical Type



Coin Type



Formula:

$$\text{Duration (years)} = \frac{\text{Nominal capacity (mAh)}}{\text{Current drain (mA) x 24 (hours) x 365 (days)}}$$

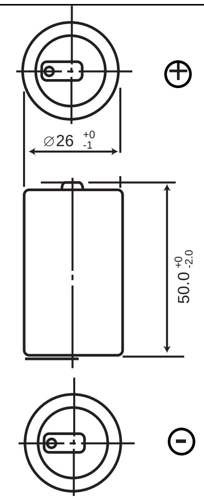
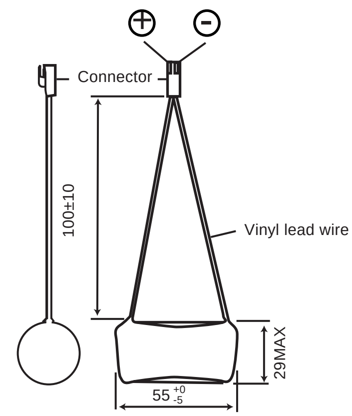
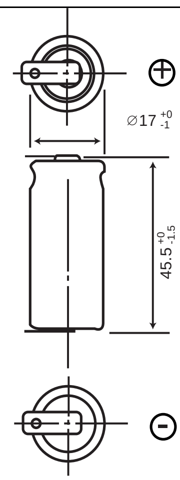
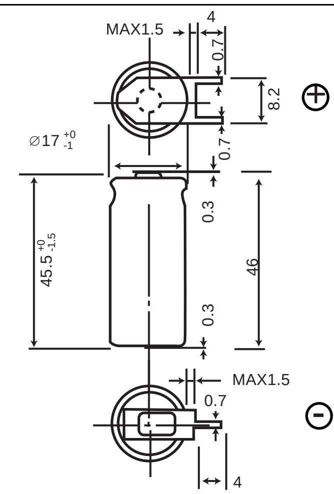
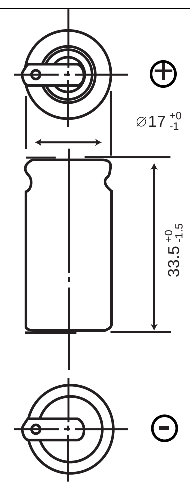
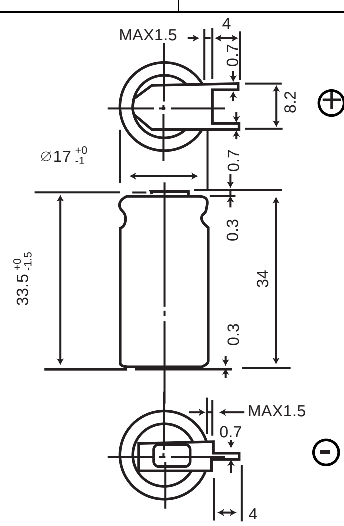
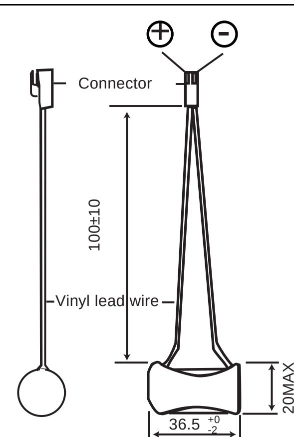
CYLINDRICAL TYPE LITHIUM BATTERIES (FOR MEMORY BACKUP)

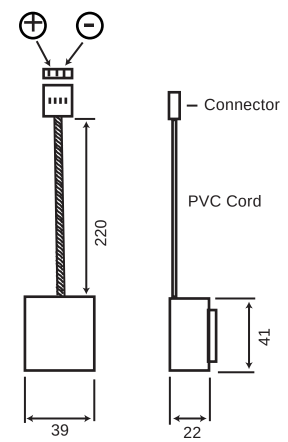
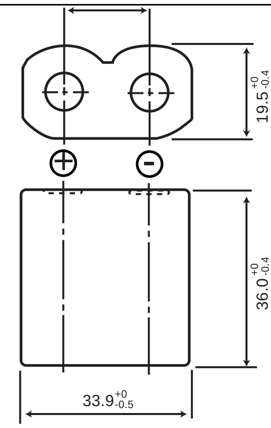
Specification Table

Model No. with terminal Bare cell Model No.	Nominal		Terminal Details	Connecting Method
	Voltage (V)	Capacity (mAh)		
BR-C BR-CT2P (Old model number: BR-C-1) BR-CC7P	 3 3	 5,000 5,000	 Tabs (12 mm) Connectors	 Lead wire soldering
BR-A *1 BR-AT2P BR-AE2P	 3 3	 1,800 1,800	 Tabs (12 mm) Tab pins	 Lead wire soldering Mounting on PC board
BR-2/3A *1 BR-2/3AT2P (Old model number BR-2/3A-1) BR-2/3AE2P BR-2/3AC2P	 3 3 3	 1,200 1,200 1,200	 Tabs (12 mm) Tab pins Connectors	 Lead wire soldering Mounting on PC board
BR-2/3A *1 BR-E3C3C *2 BR-P2 *2 BR-E2 *2	 6 6 6	 1,200 1,200 1,200	 Connectors - -	 -

*1 Higher capacity types are available
* 2 Pack lithium batteries (2 pcs in series)

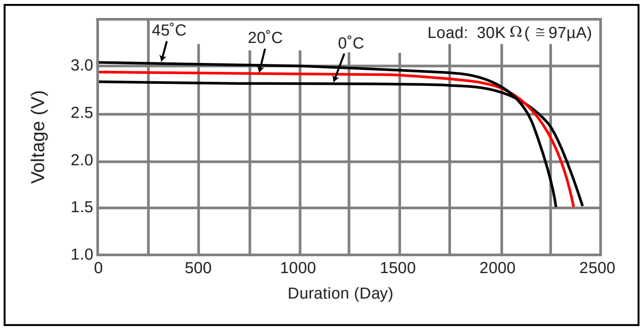
DIMENSIONS (MM)

Bare cell Model No.	Dimensions (mm)		
BR-C (3V, 5000mAh)	 **BR-CT2P**		 Connector: made by Nihon Kohkuh Densi KK Housing: IL-2S-S3L-(N) Contact: IL-C2-1-10000 **BR-CC7P**
BR-A (3V, 1800mAh) **BR-AH** (3V, 2000mAh)	 **BR-AT2P** **BR-AHT2P**		 **BR-AE2P** **BR-AHE2P**
BR-2/3A (3V, 1200mAh) **BR-2/3AH** (3V, 1350mAh)	 **BR-2/3AT2P** **BR-2/3AHT2P**	 **BR-2/3AE2P** **BR-2/3AHE2P**	 Connector: made by JAE Housing: IL-2S-S3L-(N) Contact: IL-C2-1-10000 **BR-2/3AC2P** **BR-2/3AHC2P**

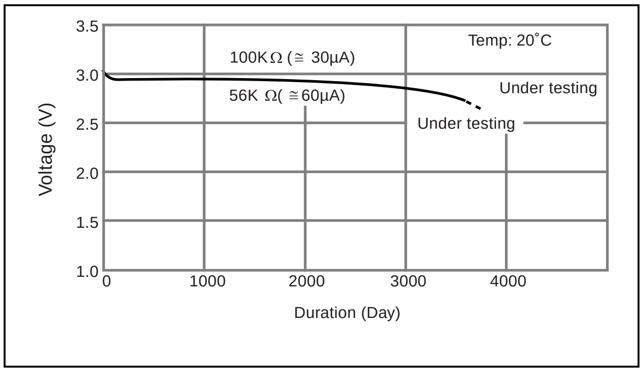
Bare cell Model No.	Dimensions (mm)	
BR-2/3A **Two batteries in series** (6V, 1200mAh)	 Connector: made by Bahgu Housing: P/N65039-033 Terminal: P/N47565 **BR-E3C3C**	 **BR-P2**

BR-C

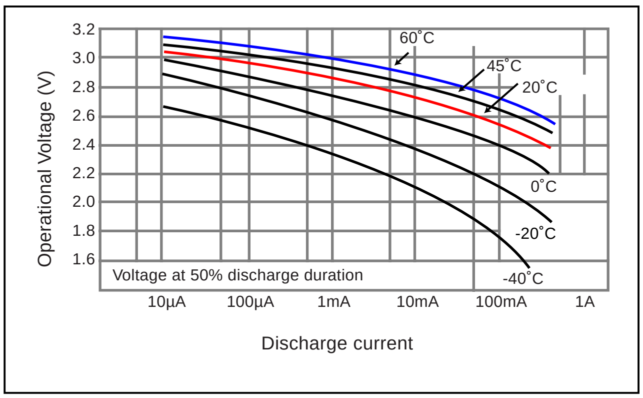
Discharging under 30 kΩ (equivalent to approx. 100μA)



Discharging under 100 kΩ (equivalent to approx. 30μA)

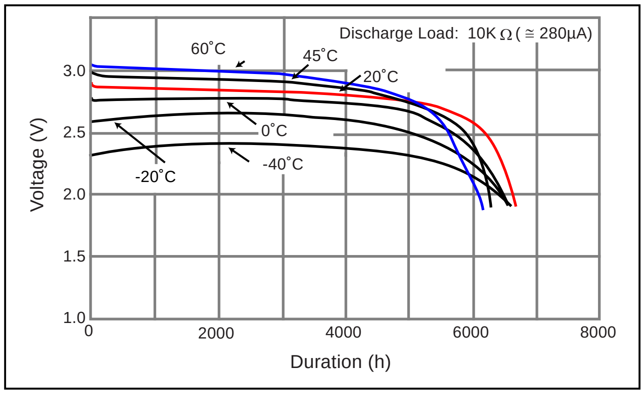


Operational voltage vs. Discharge current

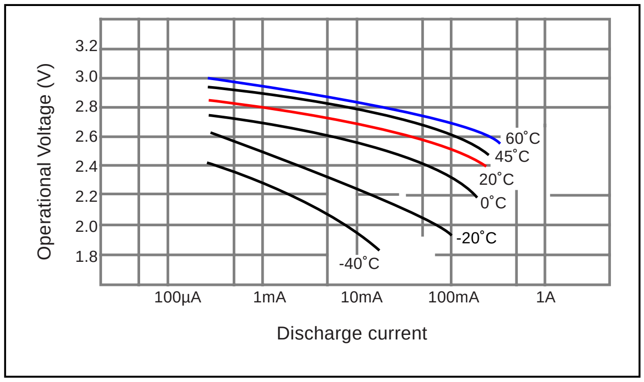


BR-A

Temperature characteristics

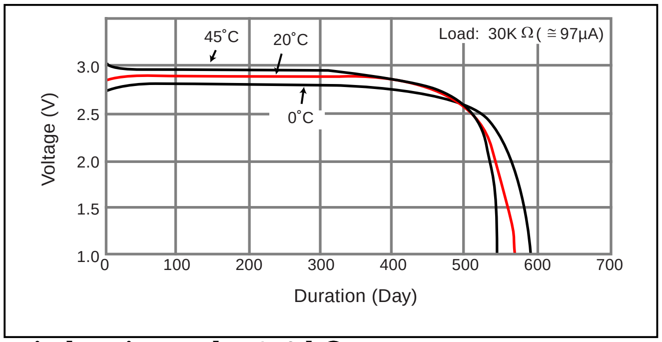


Operational voltage vs. Discharge current

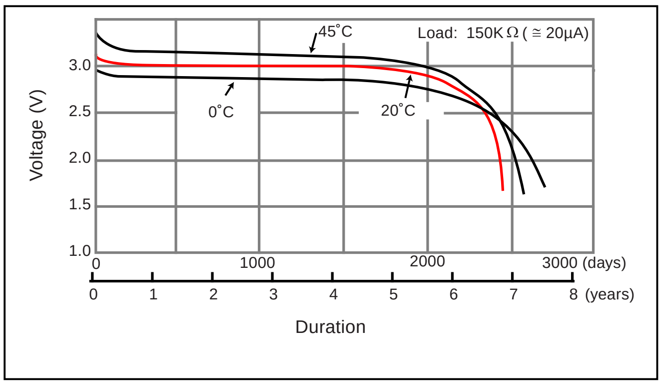


BR-2/3A

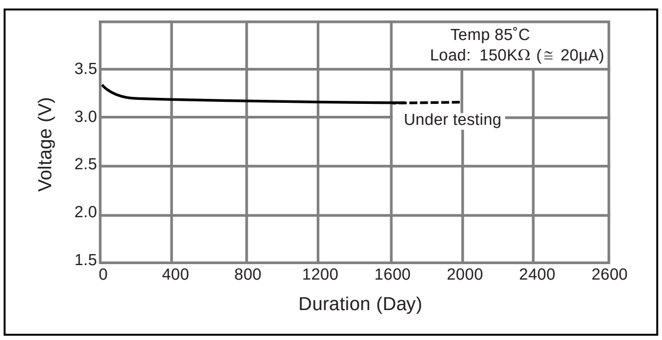
Discharging under 30 kΩ (equivalent to approx. 100µA)



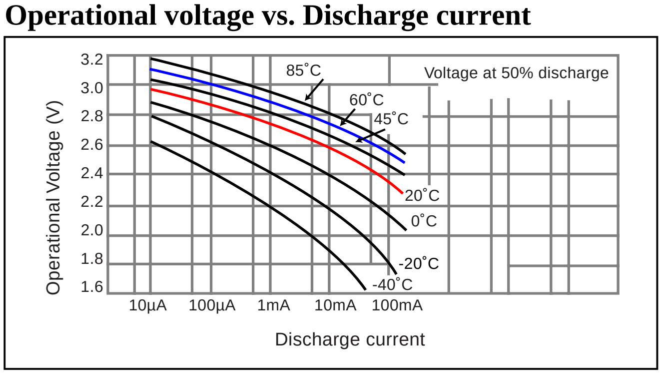
Discharging under 150 kΩ (equivalent to approx. 20µA)



High temperature discharge under 150 kΩ (equivalent to approx. 20µA)

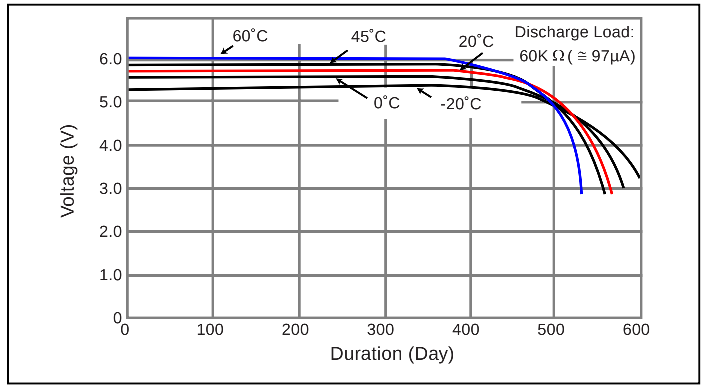


Operational voltage vs. Discharge current

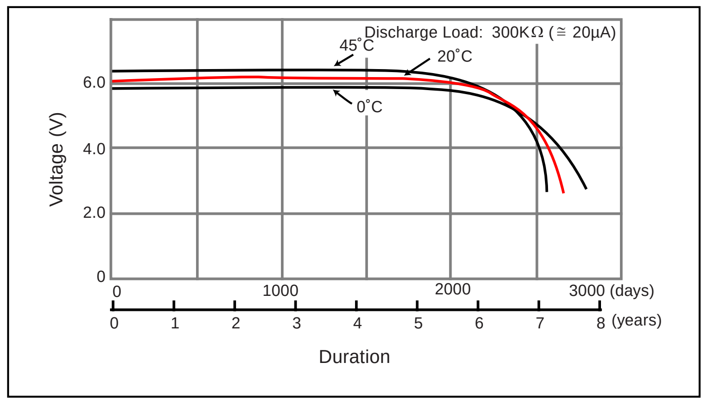


BR-E3C3C,BR-P2P

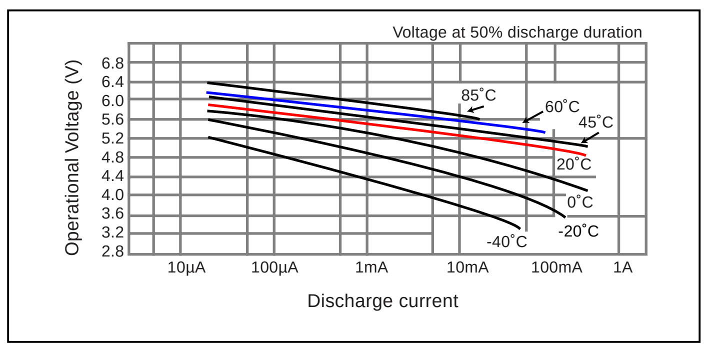
(BR-2/3A Two batteries in series) Discharge characteristics



Discharge characteristics



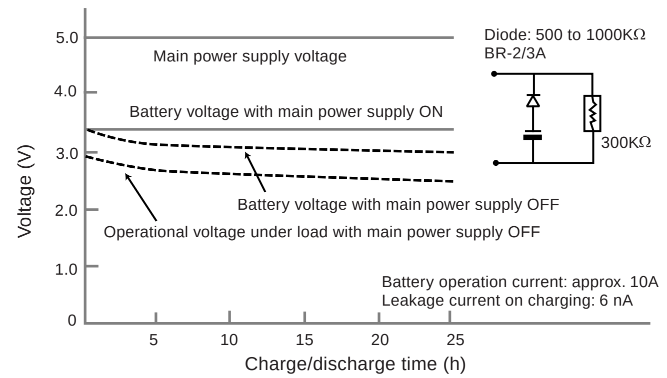
Operational voltage vs. Discharge current



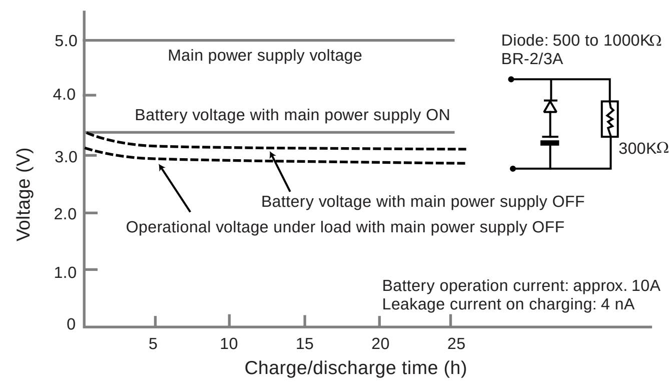
REFERENCE CHARACTERISTICS

- **Memory backup circuit**

Example of voltage characteristics when using a typical silicone diode (20˚C)

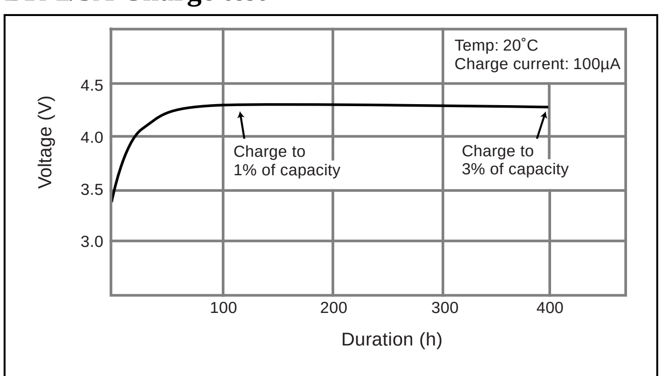


Example of voltage characteristics when using a schottky barrier diode (20˚C)

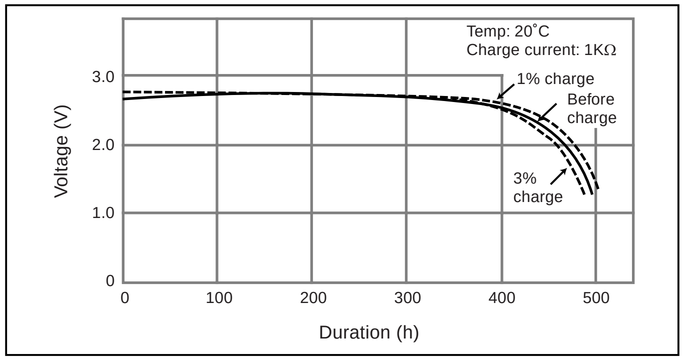


- **Test assuming diode leakage current**
  As the primary battery, graphite fluoride lithium batteries are basically non-rechargeable. Insertion of the inverse current blocking diode is required when the batteries are used together with other power sources. Select a proper diode for inverse current blocking so that the total charging capacity of the diode for current leakage is no more than 1% of the nominal capacity of the battery. The result of charge tests, assuming charging by leakage current, is shown below.

BR-2/3A Charge test

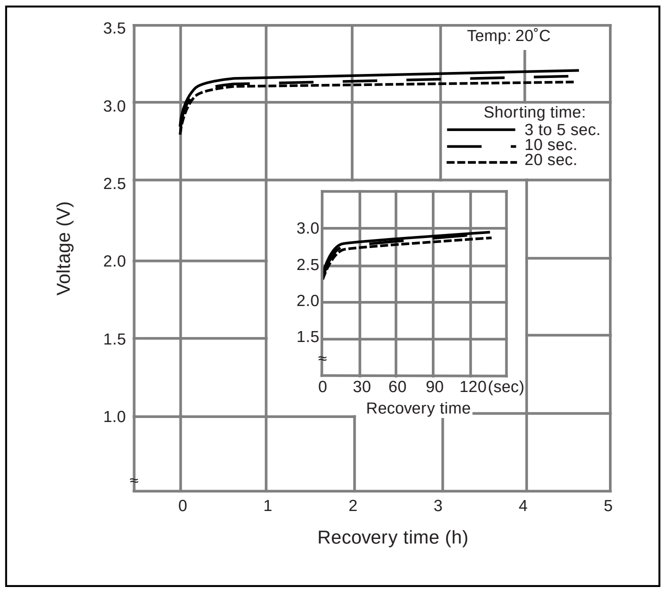


BR-2/3A Discharge test after charging



- On shorting, battery voltage immediately drops to 0V, then gradually recovers from the open state. However, it takes time to restore the initial voltage. Notice that measurement of the open voltage immediately after shorting may lead to a misjudgment that the battery is abnormal. An example of voltage recovery after shorting is shown in the graph below.

BR-2/3A voltage recovery after shorting



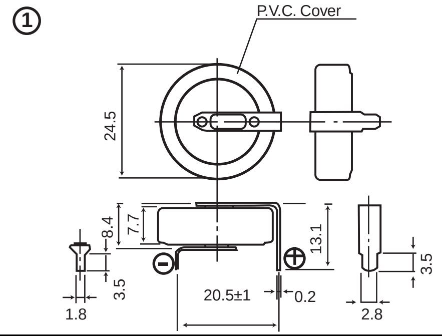
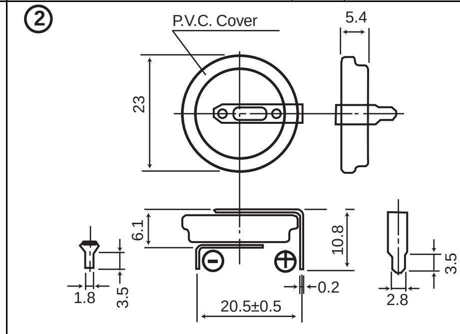
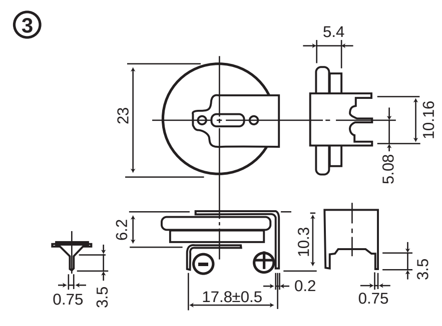
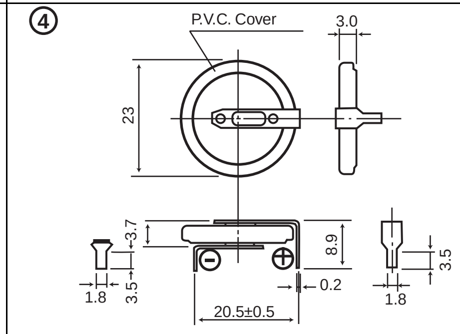
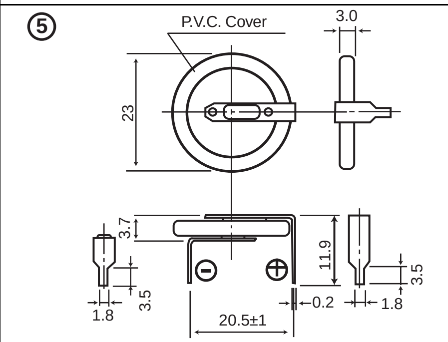
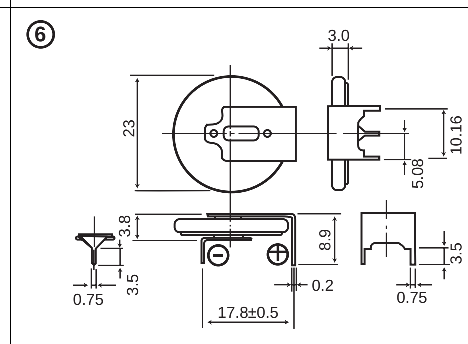
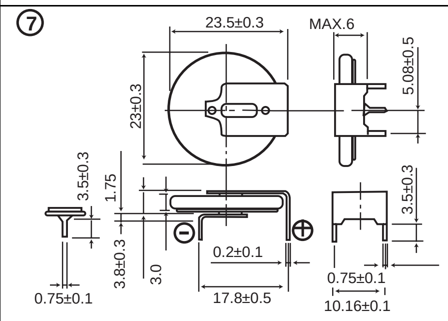
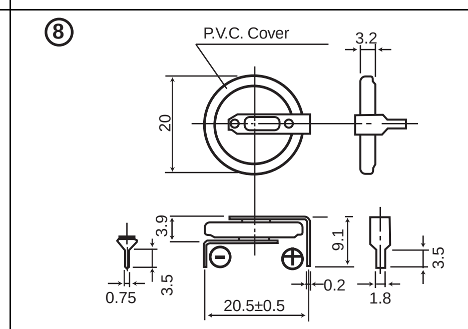
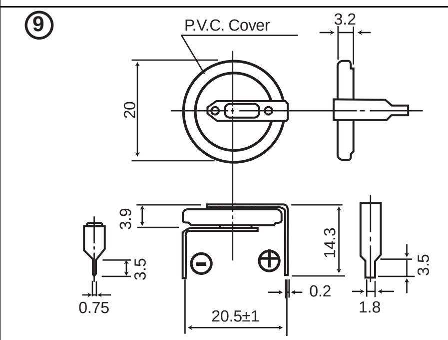
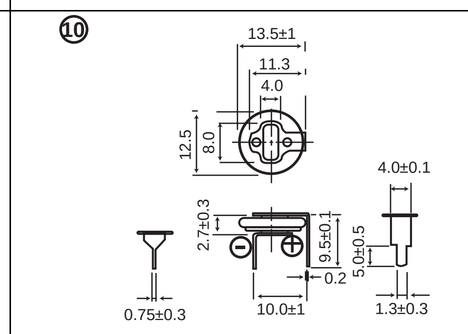
COIN TYPE LITHIUM PRIMARY- BATTERIES (BR & CR SERIES)

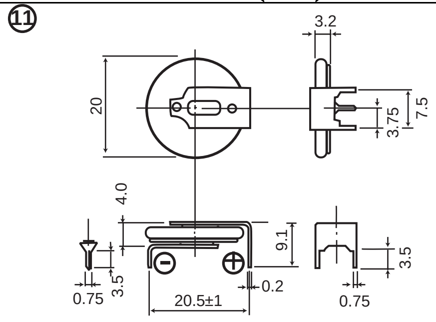
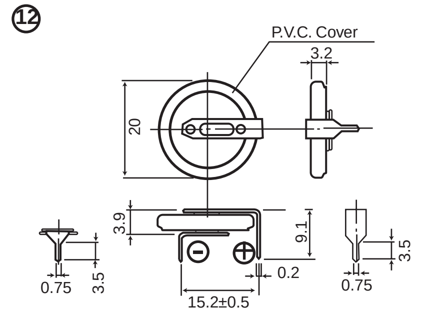
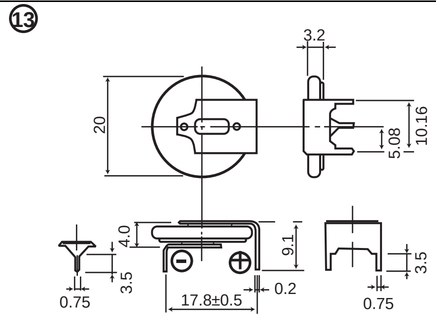
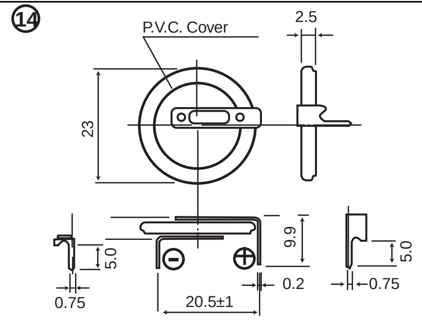
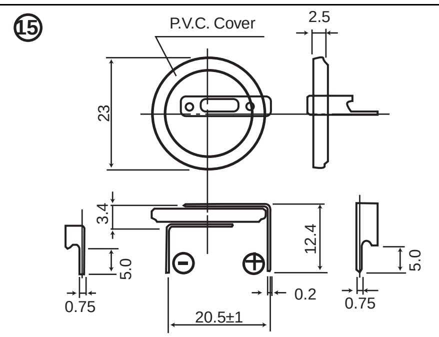
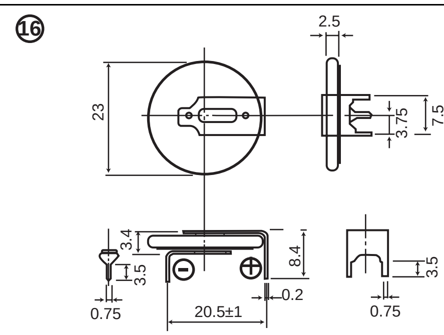
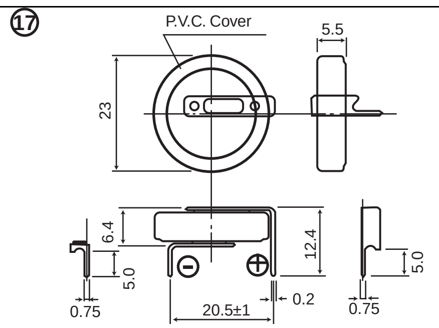
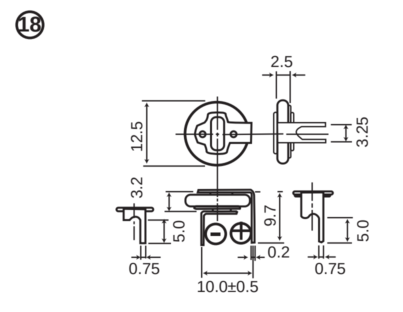
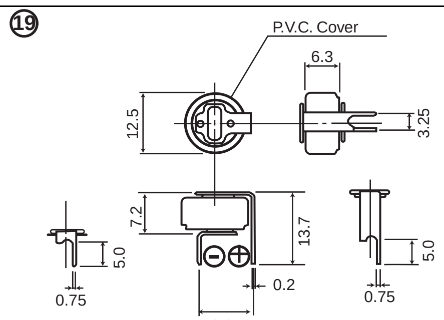
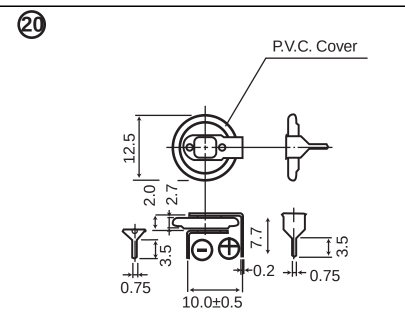
Specification Table (Coin type lithium batteries with terminals for memory backup application)

Type	Model No.	P.V.C. Cover: With P.V.C. cover	P.V.C. Cover: Without P.V.C. cover	Configuration chart No.	Characteristics: Nominal Voltage (V)	Characteristics: Nominal capacity (mAh)	Product Availability: Standard	Product Availability: Special	CR: Availability	CR: Nominal capacity (mAh)
H type	CR2477	/1HF	/1HE	1	3	1,000	⊗			
	CR2354	/1HF	/1HE	2	3	560	⊗			
		/1GUF	/1GU	3	3	560		⊗		
	BR2330	/1HF	/1HE	4	3	255	⊗		⊗	(265mAh)
		/1HH		5	3	255	⊗		⊗	(265mAh)
		/1GUF	/1GU	6	3	255		⊗	⊗	(265mAh)
		/1HF1	/1HE1	24	3	255			⊗	(265mAh)
	CR2330		/1GU7	7	3	265				
	BR2032	/1HF1	/1HF1	8	3	190	⊗		⊗	(220mAh)
		/1HM		9	3	190	⊗		⊗	(220mAh)
			/1HG	11	3	190		⊗	⊗	(220mAh)
		/1HS	/1HSE	12	3	190	⊗		⊗	(220mAh)
		/1GUF	/1GU	13	3	190		⊗	⊗	(220mAh)
		/1HF	/1HE	23	3	190			⊗	(220mAh)
	CR2032		/1HU3	22	3	220				
	BR2325	/1HC	/1HB	14	3	165	⊗			
		/1HM		15	3	165	⊗			
			/1HG	16	3	165		⊗		
		/2HC		17	6	165		⊗		
	BR1225	/1HC	/1HB	18	3	48	⊗			
		/2HC		19	6	48		⊗		
	BR1220	/1HF	/1HE	20	3	35	⊗		⊗	(35mAh)
	CR1220		/1HM5	10	3	35		⊗		
	CR1632	/1HF	/1HE	21	3	125		⊗		
V type	CR2477	/1VC	/1VB	25	3	1,000	⊗			
	CR2354	/1VC	/1VB	26	3	560	⊗			
	BR2330	/1VC	/1VB	27	3	255			⊗	(265mAh)
		/1GVF	/1GV	29	3	255		⊗	⊗	(265mAh)
	BR2032	/1VC1		30	3	190	⊗		⊗	(220mAh)
		/1VC3		32	3	190		⊗	⊗	(220mAh)
		/1GVF	/1GV	33	3	190		⊗	⊗	(220mAh)
	CR2032	/1VS1		31	3	220		⊗		
	BR3032	/1VC		28	3	500		⊗	⊗	(500mAh)
	BR2325	/1VN		34	3	165		⊗		
		/1VC2		35	3	165	⊗			
	BR1220	/1VC	/1VB	36	3	35	⊗		⊗	(35mAh)
Others	CR1616		/1F2	38	3	55		⊗		
	BR3032	/1F2		37	3	500	⊗		⊗	(500mAh)
	BR2032	/1T2		39	3	190	⊗		⊗	(220mAh)
		/1F4		40	3	190		⊗	⊗	(220mAh)
		/1F2		42	3	190	⊗		⊗	(220mAh)
	BR2330	/1F3		43	3	255	⊗		⊗	(265mAh)
		/1F4C		41	3	255			⊗	(265mAh)
	BR2016	/1F2		44	3	75	⊗		⊗	(90mAh)
	BR1225	/1VF	/1F4	45	3	48	⊗			
	BR1220	/1VC		46	3	35	⊗		⊗	(35mAh)

Many other items with terminals are available. Please contact Panasonic for details

DIMENSIONS (MM)

Model No.	Dimension (mm)	Model No.	Dimensions (mm)
CR2477/1HF 1HE		CR2354 /1HF 1HE	
CR2354/1GUF 1GU		BR/CR2330/1HF 1HE	
BR/CR2330/1HH		BR/CR2330/1GU 1GUF	
CR2330/1GU7		BR/CR2032/1HF1 1HE1	
BR/CR2032/1HM		CR1220/1HM5	

Model No.	Dimension (mm)	Model No.	Dimensions (mm)
BR/CR2032/1HG		BR/CR2032/1HS 1HSE	
BR/CR/2032/1GUF 1GU		BR2325/1HC 1HB	
BR2325/1HM		BR2325/1HG	
BR2325/2HC		BR1225/1HC 1HB	
BR1225/2HC		BR/CR1220/1HF 1HE	

DIMENSIONS (MM) - CONTINUED

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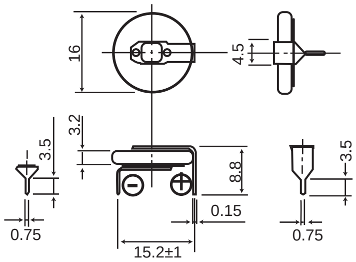
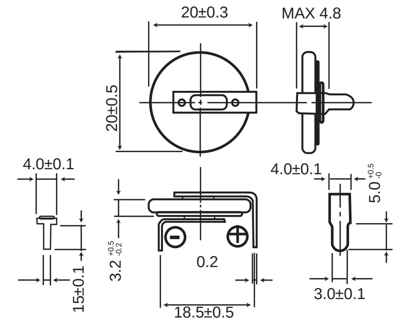
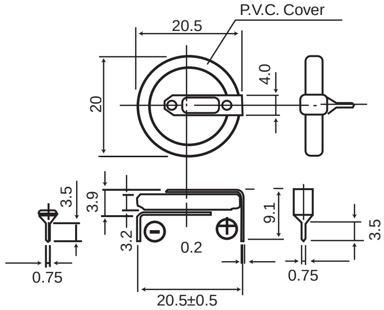
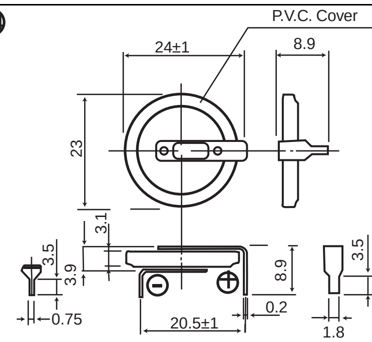
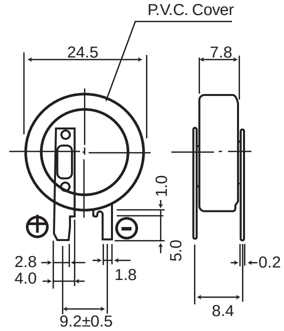
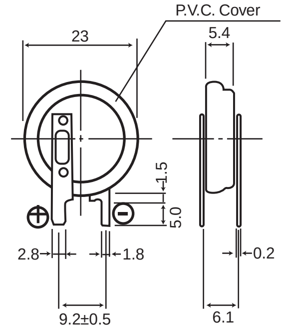
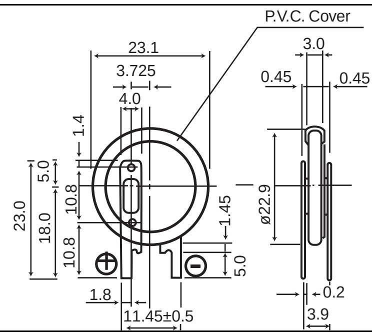
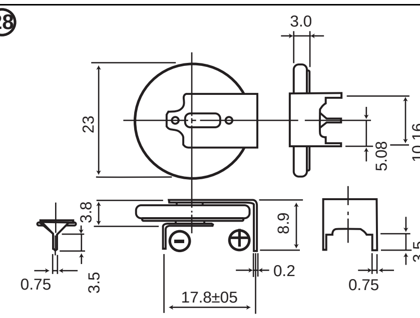
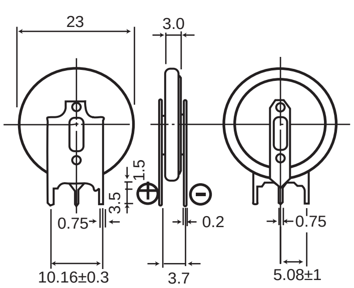
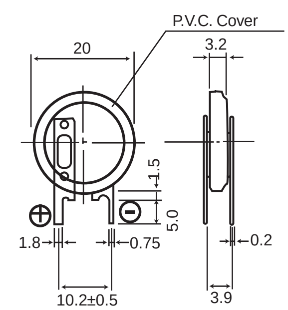
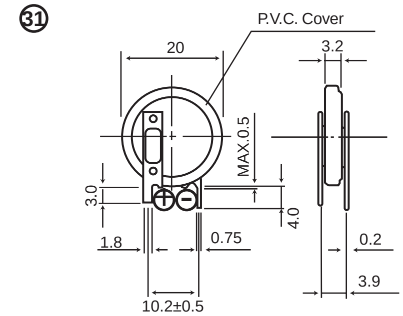
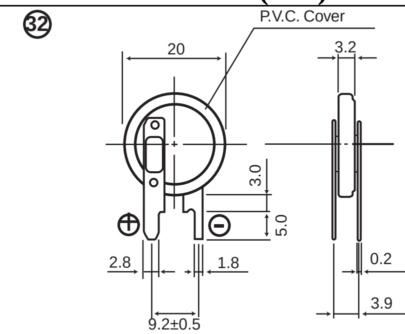
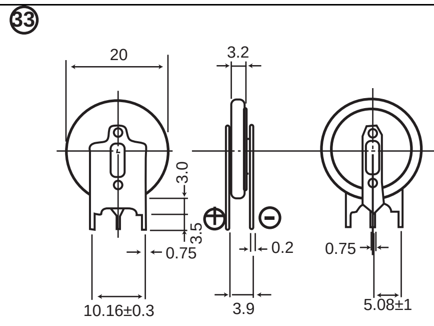
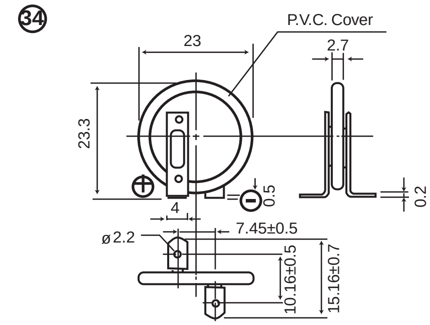
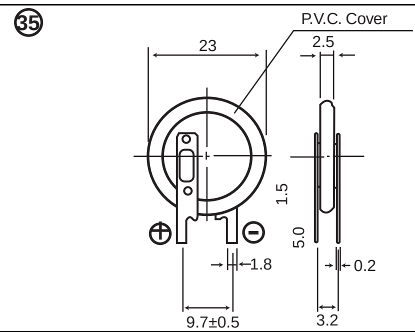
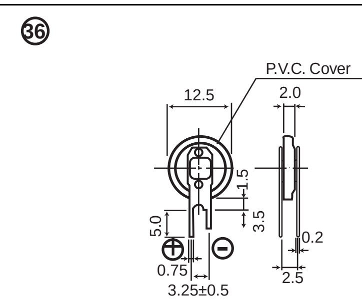
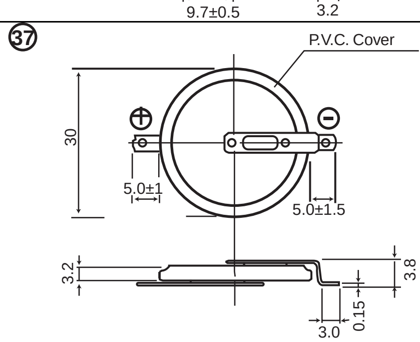
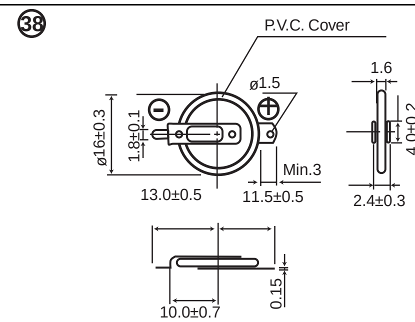
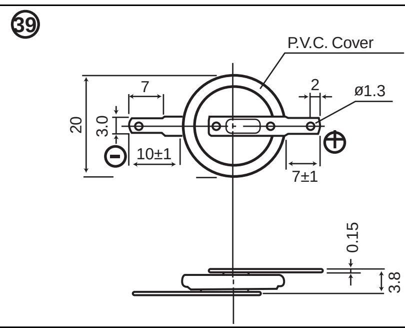
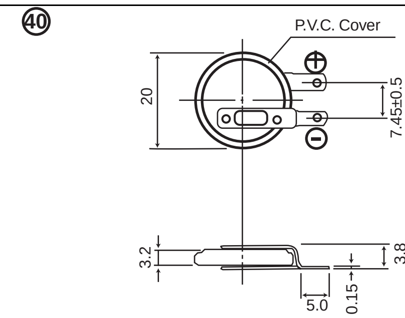
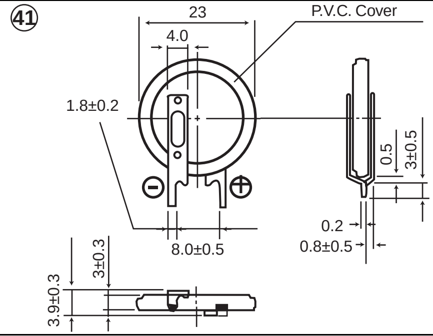
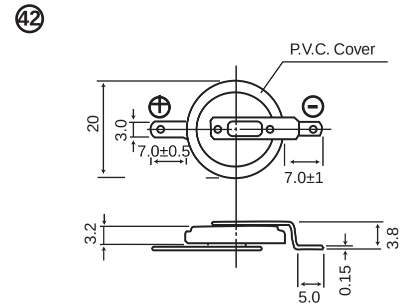
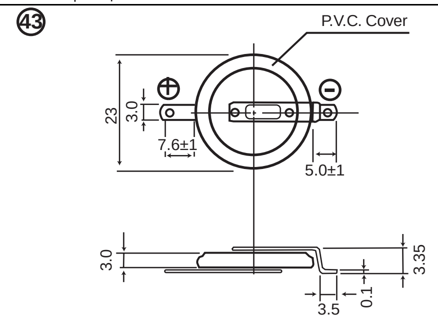
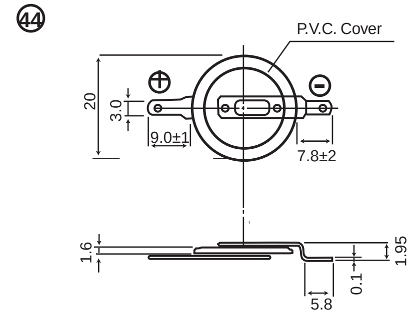
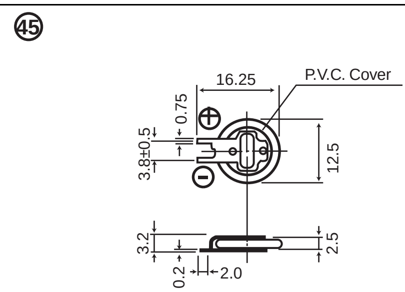
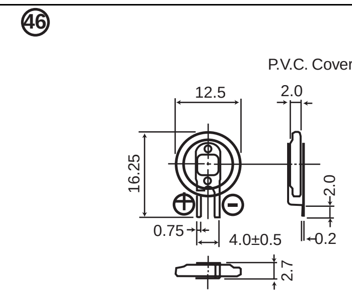
CR1632/1HE 1HF	(21) 	**CR2032/1HU3**	(22) 
BR/CR2032/1HF 1HE	(23) 	**BR/CR2330/1HF1 1HE1**	(24) 
CR2477/1VC 1VB	(25) 	**CR2354/1VC 1VB**	(26) 
BR/CR2330/1VC 1VB	(27) 	**BR/CR3032/1VC**	(28) 
BR/CR2330/1GVF 1GV	(29) 	**BR/CR2032/1VC1**	(30) 

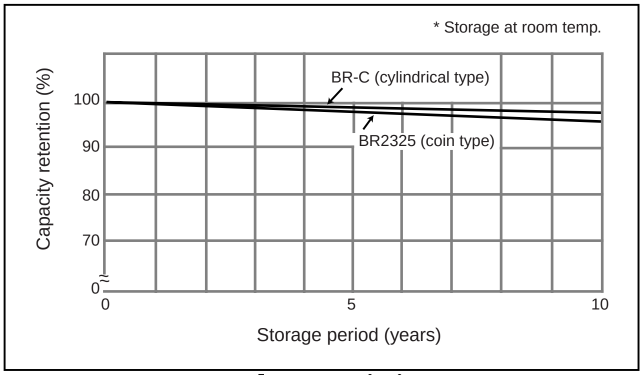
DIMENSIONS (MM) - CONTINUED

Model No.	Dimension (mm)	Model No.	Dimensions (mm)
CR2032/1VS1		BR/CR2032/1VC3	
BR/CR2032/1GVF 1GV		BR2325/1VN	
BR2325/1VC2		BR/CR1220/1VC 1VB	
BR/CR3032/1F2		CR1616/1F2	
BR/CR2032/1T2		BR/CR2032/1F4	

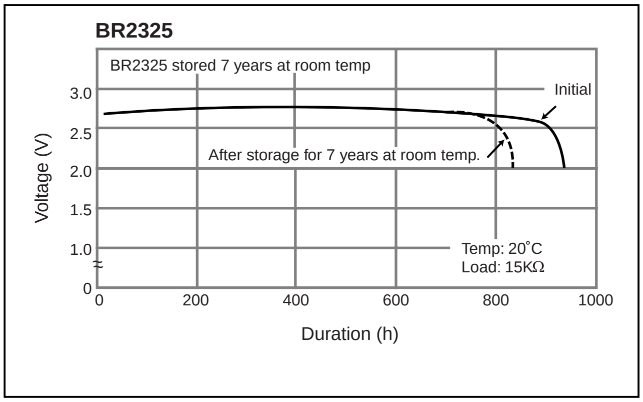
DIMENSIONS (MM) - CONTINUED

Model No.	Dimension (mm)	Model No.	Dimensions (mm)
BR/CR2330/1F4C		BR/CR2330/1F2	
BR/CR2330/1F3		BR/CR2016/1F2	
BR1225/1F4 1VF		BR/CR1220/1FC	

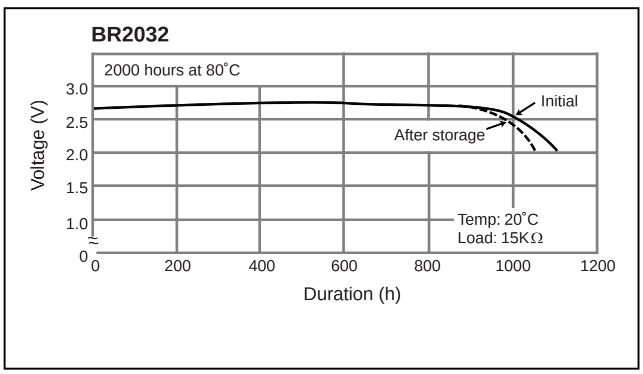
Storage characteristics (BR coin type)



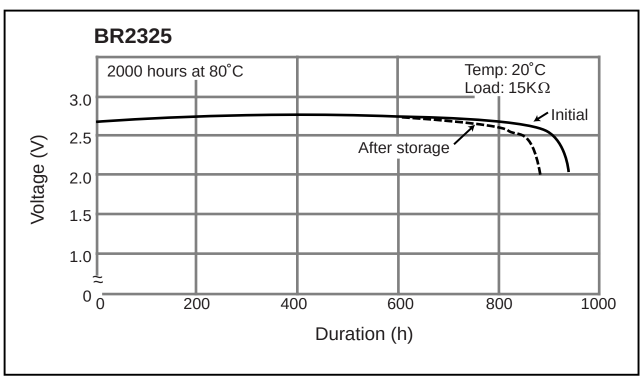
Long term storage characteristics: BR2325



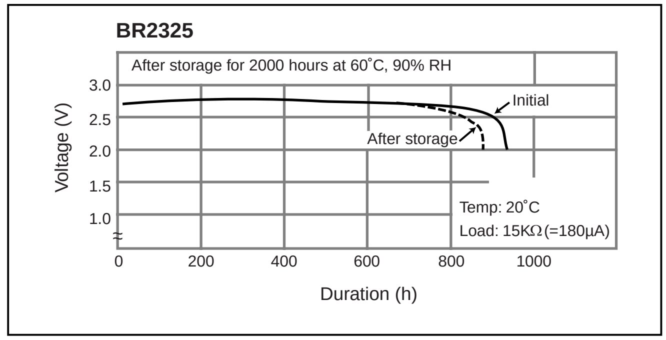
High temperature storage characteristics (80°C): BR2032



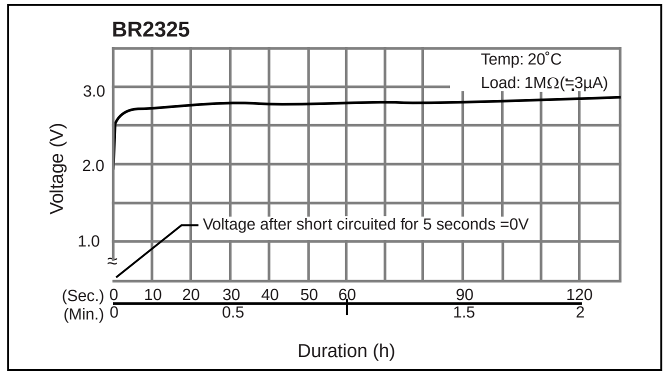
High temperature storage characteristics (80°C): BR2325



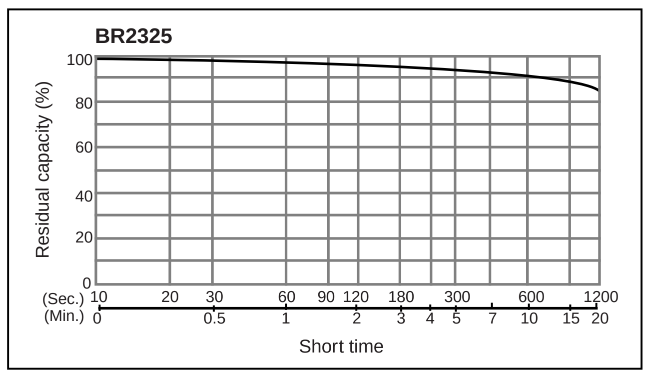
High temperature and high humidity storage characteristics



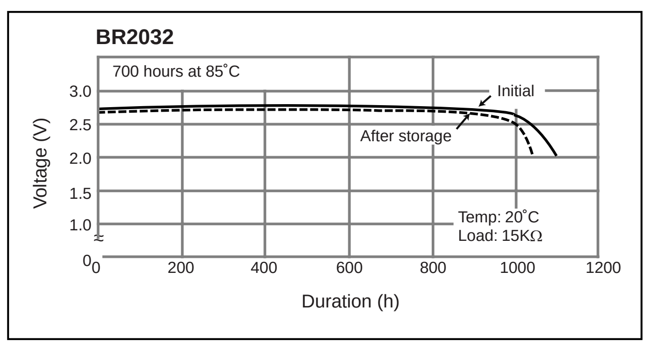
Example of voltage recovery after short-circuited: BR2325



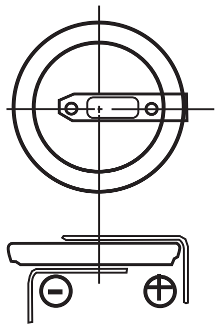
Capacity retention after short-circuited: BR2325



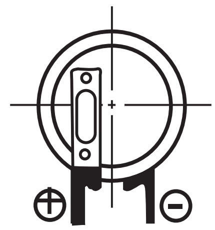
High temperature storage characteristics (80°C): BR2032



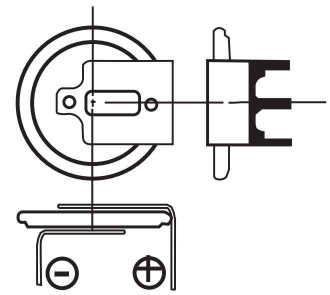
H Type



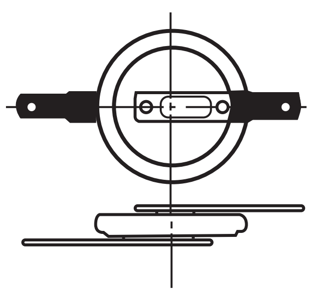
V Type



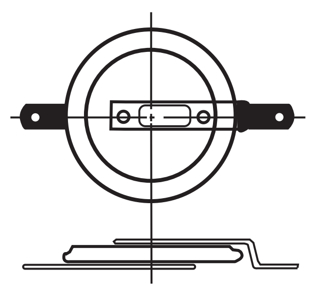
G Type



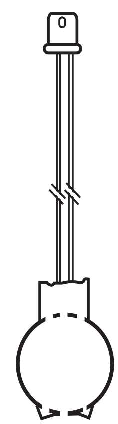
T Type



F Type



S Type



PRECAUTIONS

Please be sure to observe the following instructions. Improper handling of batteries may cause deterioration of their performance.

1. **Short**
- When batteries are shorted, it takes time for the voltage to recover. Checking should not be done immediately. Because shorting also leads to deterioration of capacity, avoid shorting batteries except in dip-soldering.
- For measuring voltage, select an instrument with high input impedance (10 MΩ or higher).

2. **Charge**
- Non-rechargeable batteries require an inverse current blocking diode in the equipment circuit. The inverse current of the diode must be very small. For coin type lithium batteries, select a diode whose total charging capacity is within 3 % of the nominal capacity of the concerned battery; and for cylindrical type lithium batteries, select a diode of total charging capacity within 1 % of the battery nominal capacity.

3. **Battery terminal soldering**

When mounting batteries onto circuits, do not solder directly to batteries; instead use batteries with terminals. When soldering batteries with terminals, observe the following directions:
- **Never use reflow soldering**

  In reflow soldering, the battery body is directly heated to high temperatures, causing solution leakage; deterioration of battery performance; or danger of rupture or ignition.
- **Soldering with a soldering iron**

  Take care not to touch the battery body directly with the soldering iron. Maintain the iron tip temperature at 350°C; perform soldering quickly (within 5 seconds).
- **Automatic dip-soldering**

  Do not allow the temperature of the battery body to exceed 85°C. Use caution; it is possible to have a temperature rise in the battery after dipping due to ambient heat depending on the temperature conditions in the dipping device. The basic conditions should be: Solder dipping bath temperature of up to 260°C, dipping time of within 5 seconds, and within twice dipping.

4. **Cleaning and drying**
- Make sure to use a non-conductive cleaning solution. In a conductive solution, batteries may discharge, causing deterioration of battery performance such as voltage drop. Make sure to dry batteries at a temperature below 85°C. If the temperature of the battery body exceeds 85°C, the gasket may be deformed by heat, causing solution leakage or deterioration of battery performance.

5. **Mounting**
- Position batteries so that the inter-electrode insulation is not spoiled by foreign materials, such as dust.
- Avoid exposing batteries to high temperatures for a long period of time by positioning them away from high-temperature locations.
- Do not place a battery-mounted PC board, etc. on a conductive table during assembly, or the batteries may short.
- Do not bring a battery-mounted PC board, etc. into contact with conductive antistatic mats during transportation, as this will form a discharge circuit, draining battery capacity. Substitute an insulative material for the mat.

6. **Handling batteries**
- Avoid inversion of polarity, disassembling, heating or exposure to high temperatures, and direct application of solder or spot-welding.
- Do not apply an excessive force to battery terminals as the terminals may become detached or broken.
- Wear gloves or finger caps of rubber or cotton when handling batteries to keep them clean.
- For long-term storage, keep batteries below ordinary temperature and humidity, to help avoid deterioration of capacity due to shorting, etc.

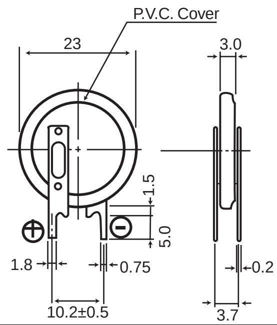
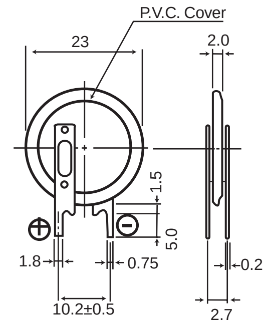
7. **UL standard**
- In handling/using UL-standard application batteries, observe the conditions outlined in this handbook.

Specification Table (Vanadium pentoxide lithium rechargeable batteries with terminals)

Type	Model No.	P.V.C. Cover		Fig. No.	Nominal		Product availability	
		With P.V.C. cover	Without P.V.C. cover		Voltage (V)	Capacity (mAh)	Standard	Special
V type	VL2330	/1VC		1	3	50	⊗	
	VL2320	/1VC		2	3	30	⊗	
	VL2020	/1VC		3	3	20	⊗	
	VL1220	/1VC		4	3	7	⊗	
G type	VL2020	/1GU7		5	3	20	⊗	
	VL3032	/1GUF		-	3	100	⊗	
H type	VL2330	/1HF		6	3	50	⊗	
	VL2320	/1HF		7	3	30	⊗	
	VL2020	/1HF		8	3	20	⊗	
F type	VL621		/F9D	9	3	1.5	⊗	
	VL3032	/1F2		10	3	100	⊗	
	VL2320	/1F2		11	3	30	⊗	
	VL2330	/1F3		12	3	50	⊗	
	VL1216		/1F5U	13	3	5	⊗	
	VL1220	/1FC		14	3	7	⊗	
Connecting type	VL2330	/1S22		15	3	50	⊗	
	VL2330	/2S22		16	6	50	⊗	

- See page 61 for precautions in charging and handling. Recommended charging circuit is shown on page 52.
- Items with terminals other than those listed above are also available. Contact Panasonic for details.

DIMENSIONS (MM)

<table>
<tr><th>Model No.</th><th>Dimension (mm)</th><th>Model No.</th><th>Dimensions (mm)</th></tr>
<tr><td>VL2330/1VC
(50mAh)</td><td>①

</td><td>VL2320/1VC
(30mAh)</td><td>②

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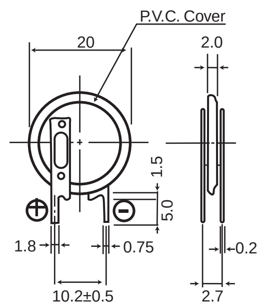
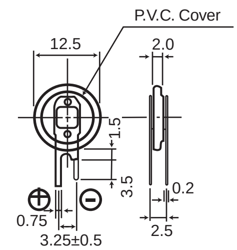
<tr><td>VL2020/1VC
(20mAh)</td><td>③

</td><td>VL1220/1VC
(7mAh)</td><td>④

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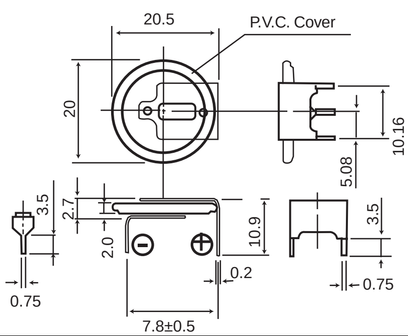
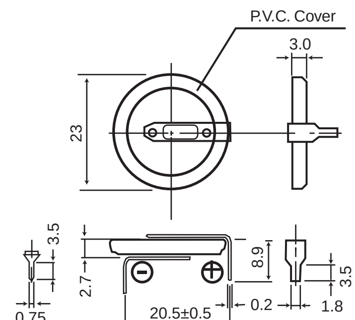
<tr><td>VL2020/1GU7
(20mAh)</td><td>⑤

</td><td>VL2330/1HF
(50mAh)</td><td>⑥

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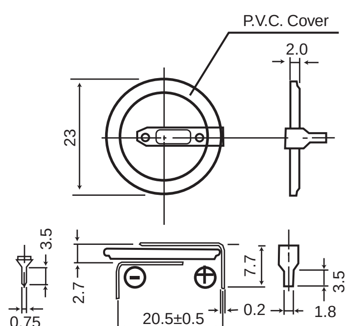
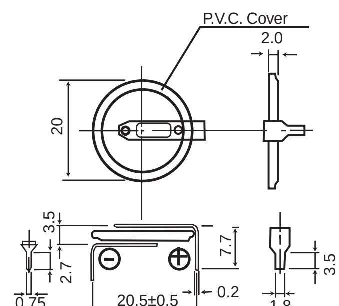
(30mAh)</td><td>⑦

</td><td>VL2020/1HF
(20mAh)</td><td>⑧

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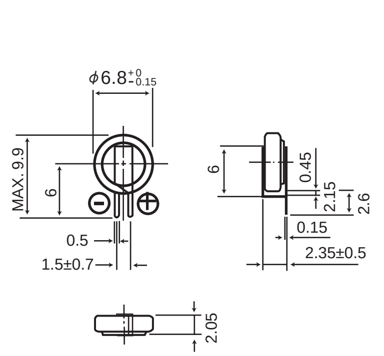
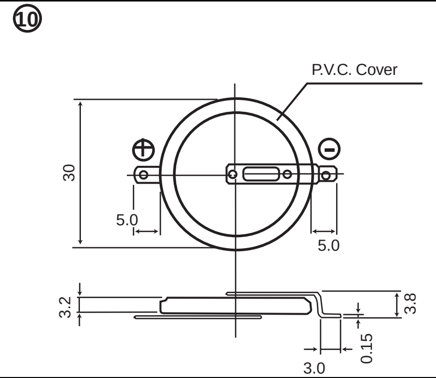
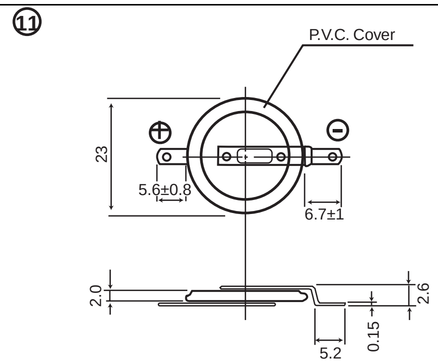
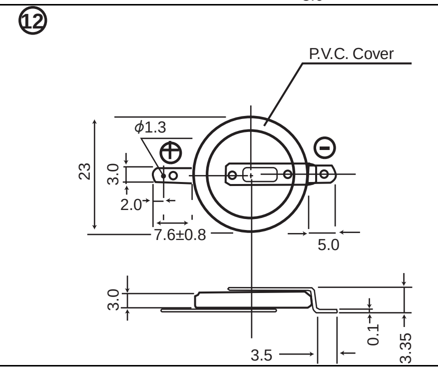
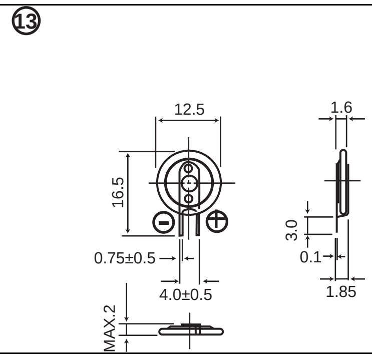
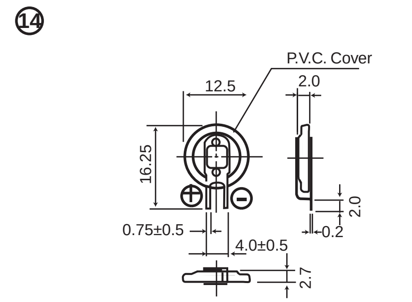
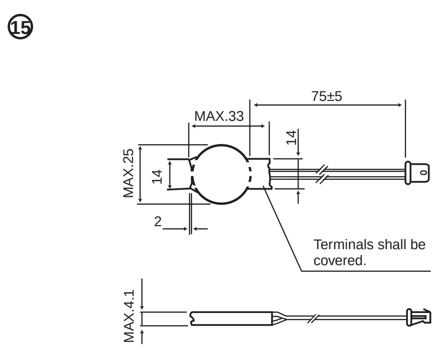
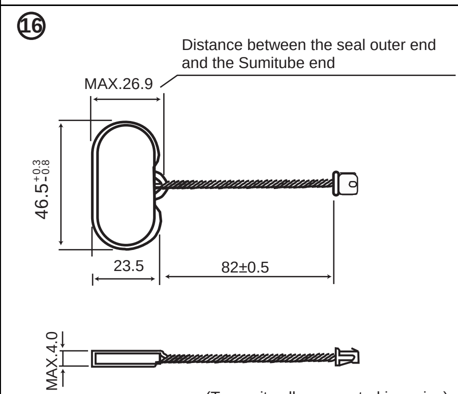
DIMENSIONS (MM) - CONTINUED

Model No.	Dimension (mm)	Model No.	Dimensions (mm)
VL621/F9D (1.5mAh)		VL3032/1F2 (100mAh)	
VL2320/1F2 (30mAh)		VL2330/1F3 (50mAh)	
VL1216/1F5U (5mAh)		VL1220/1FC (7mAh)	
VL2330/1S22 (50mAh)		VL2330/2S22 (50mAh)	 (Two unit cells connected in series)

Use of the battery holder is recommended for user replaceable lithium batteries.

Overview

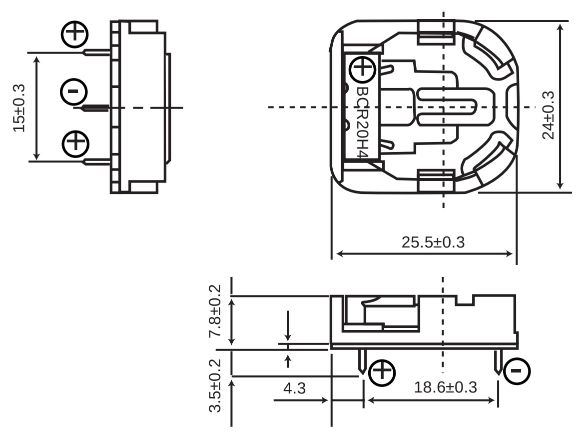
The battery holder is designed for sure and easy loading/removal of Panasonic coin type lithium batteries in/from equipment, enabling the batteries to fully exploit their capabilities as the backup power supply in C-MOS RAM memory and microcomputer memory.

Features

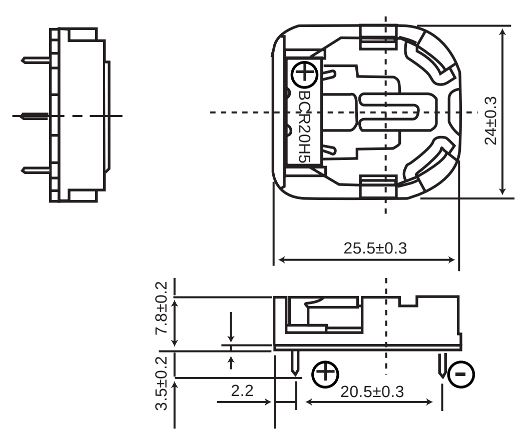
Applicable batteries are BR2032 and CR2032.
One vertical type and two horizontal types; all are designed so as to prevent inverted insertion of the battery.

Dimensions (mm)

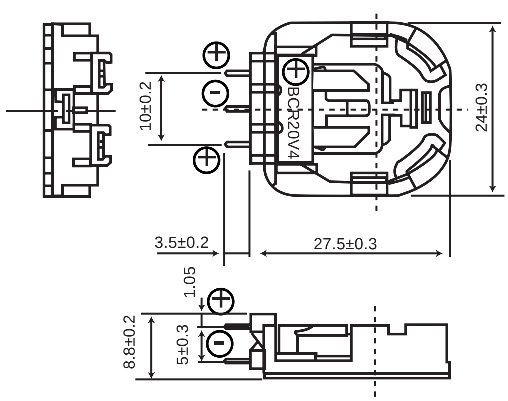
BCR20H4



BCR20H5



BCR20V4



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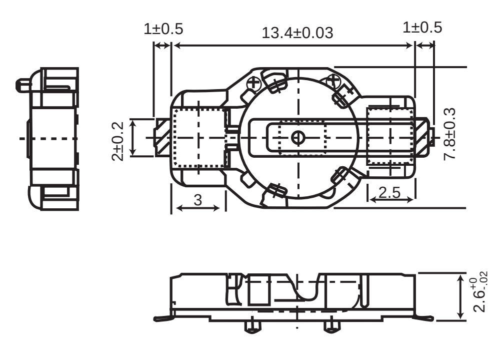


5-1 Department of Transportation (DOT)

The United States Department of Transportation (DOT) regulates the transportation of all lithium cells and batteries in commerce. All Panasonic lithium batteries are not subject to the requirements of the DOT Subchapter C, Hazardous Material Regulations because each of our batteries meet the requirements of 49 CFR 173.185(b). The only exception to this our BR-C battery which contains 1.7 grams of lithium per cell and is not subject to the Hazardous Material Regulations because it meets the requirements of 173.185(c).

All Panasonic lithium batteries are exempt from the DOT Hazardous Materials Subchapter as long as they are separated to prevent short circuits and packed in strong packing for conditions normally encountered in transportation.

5-2 International Civil Aviation Organization (ICAO)

All Panasonic lithium batteries are considered non-dangerous by the International Civil Aviation Organization (ICAO) because they meet all the requirements of Special Provision"A45". The batteries must be shipped in strong packaging and packaged in a manner that prevents them from short circuiting.

5-3 International Air Transport Association (IATA)

All Panasonic lithium batteries are considered non-dangerous by the International Air Transport Association (IATA) because they meet all the requirements of Special Provision"A45". The batteries must be shipped in strong packaging and packaged in a manner that prevents them from short circuiting.

If you build these cells into a battery pack, you must also assure that they continue to remain unregulated (i.e.-meet the requirements of 49 CFR 173.185(b) or (c)) or you must ship them in compliance with applicable regulations.

SECURITY EXPORT CONTROL

"Security export control" is to observe the legislation provided to maintain international peace and safety by preventing the proliferation of devastating weapons (nuclear weapons, chemical weapons and biological weapons) and the excessive buildup of conventional weapons.

Whereas the export control to communist areas by COCOM was lifted on March 31, 1995, some COCOM-listed items, after partial amendment (June 1994), are still the object of regulation by "Security export control." All Panasonic lithium batteries are exempt from Item 7 in Annex Table 1 of Export and Trade Control Regulation. When an exemption certificate is required for such as exporting your products or if you have any questions, contact us.

Precautions in disposing lithium batteries

Warning

When disposed of improperly, lithium batteries may short, causing them to become hot, burst or ignite and cause serious personal injury.

1. Shorting

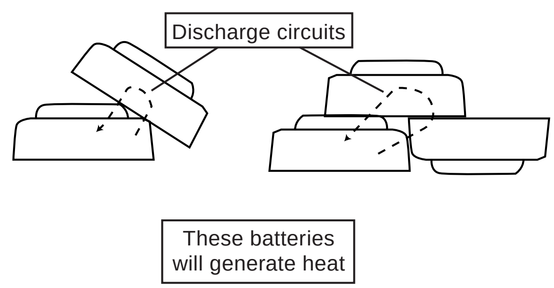
Sometimes, electricity remains in “exhausted" lithium batteries, which contain flammable substances such as lithium metal and organic solvents. If the (+) and (-) terminals of a battery are brought into contact with each other or with other metal, the battery will short.

For instance, if batteries are mixed, piled up, and brought into contact with each other, a current will flow as illustrated in the right, which may cause heating, rupture, or ignition of batteries.

Do not allow batteries to be mixed and piled.

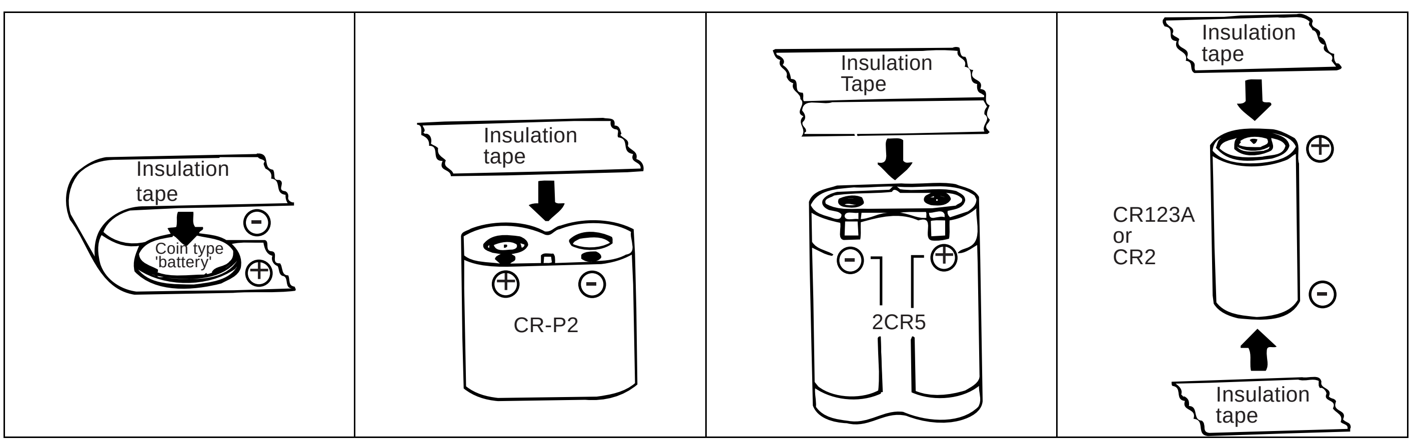
Do not allow batteries to be mixed and piled.

Schematic contact of batteries



2. When disposing of batteries

Insulate the (+) and (-) terminals of batteries with insulating tape, etc. before disposal. Examples of insulation are illustrated below.



Preventing soldering problems

The following incident was reported: In soldering a terminal-mounted battery to a PC board, heat from the solder was transferred to the battery body, whose gasket was then damaged, resulting in leakage. Please observe the following instructions for soldering:

(Precautions in soldering)

1. Never use reflow soldering

- In reflow soldering, the battery body is directly heated to high temperatures, causing solution leakage, deterioration of battery characteristics, or danger of burst or ignition.

2. Soldering of tab terminals with a solder iron

- Take care not to touch the battery body directly with the soldering iron. Maintain iron tip temperature at 350°C; perform soldering quickly (within 5 seconds).

3. Automatic dip-soldering

- Soldering with a dip-soldering bath can be used. However, do not allow the temperature of the battery body to exceed 85°C.
- In dip-soldering, the battery body temperature may rise after dipping due to the remaining heat in the dipping device.
- When a post-dipping temperature rise is observed, review the dipping condition and dipping time, and consider forced cooling of batteries after dipping.
- Recommended conditions: Solder dipping bath temperature not to exceed 260°C; dipping time within 5 seconds; and within two dips.
- In dip-soldering, the battery body temperature may rise after dipping due to remaining heat in the dipping device.
  If the battery body temperature cannot be controlled to 85°C or below in your process, consult Panasonic.

(Other precautions)

- Never apply solder directly to the battery body: it is dangerous.
- Do not weld tab terminals, etc. to the battery body: if this is required, contact Panasonic battery engineers.

Plastics with a low softening temperature are employed for the gasket and separator of batteries, and organic solvents with a low boiling point are used in the electrolyte. Therefore, heating batteries to high temperatures may cause not only damage to the gasket and separator, but leakage or deterioration of battery performance. In extreme cases, increase in the battery inner pressure may cause venting, rupture, or ignition of the battery.

Prevention of memory erasure problems

Large numbers of coin type lithium batteries are used for memory backup. However, problems with erasing valuable memory due to improper battery connections with equipment have been reported.
It is important to ensure positive contact between the battery and equipment to prevent memory erasure problems.

When batteries are to be used continuously for a long period

- Select tab-terminal-welded batteries and solder the tab to the battery-connection terminal of the device (Fig. 1).
- When battery replacement is required, use the battery holder (Fig. 2) or the battery lead wire connector (Fig. 3). A Panasonic battery holder (Fig. 2) is also available.

When batteries are to be replaced over short periods: Use batteries with no tab terminal or lead wire connector

- For preventing momentary contact failure of several ms on the circuit side, the use of a tantalum capacitor of several μF, etc. is effective (Fig. 6)
- For the connector terminal of devices, use gold/nickel-plated iron/stainless steel. Gold-plated phosphor bronze terminals provide stable contact over a long period.
- For the connecting terminal of devices, Y-shaped terminals (2-point contact) provide more stable contact for both (+) and (-) poles (Fig. 4). Contact pressure of the terminal should be no less than 2~10N (approx. 200~1000 gf) (Fig. 5).

Do not touch batteries with bare hands, as sweat (salt) will increase surface resistance, which may lead to contact failure.

Figs.1 to 6 are reference schemes.

Fig.1: (Soldering)

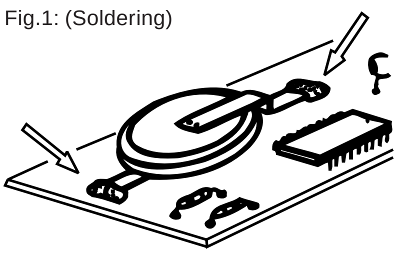


Fig. 2

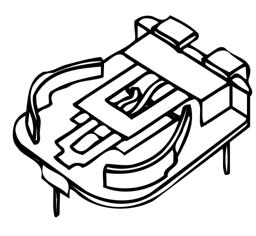


Fig. 3

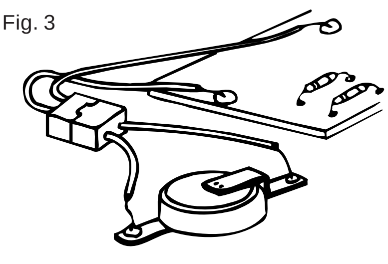


Fig. 4

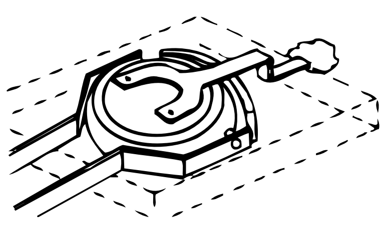


Fig. 5: (Load)

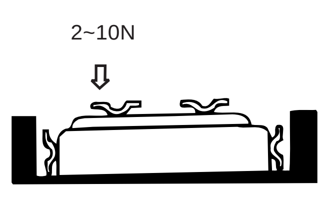
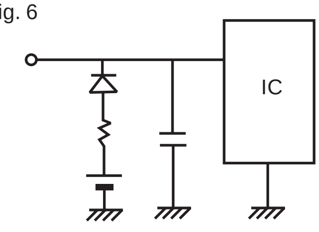


Fig. 6

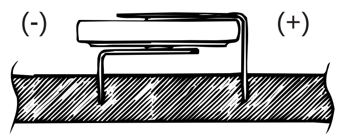


Use caution with antistatic conductive materials

Incidents have been reported where batteries with terminals for memory backup or coin type lithium batteries came into contact with antistatic conductive materials, thus forming external discharge circuits, which led to voltage drop or capacity deterioration.
In those plants which use semiconducting components such as IC and LSI, antistatic measures are widely taken, including the use of various protective materials. These materials are compounded with carbon, aluminum foil, and other metals and therefore are conductive.
The protective materials are used for packaging bags, trays, mats, sheets, films, corrugated boards, and resin cases.
For example, a protective sheet may have resistance value as low as 103 to 106Ω / cm. Therefore, if (+) and (-) terminals of a battery come in contact with the sheet, the battery circuit becomes open.
In the case of a lithium battery, a current of several A to several mA will flow, causing voltage drop and capacity deterioration.
Accordingly, use extreme caution not to allow (+) and (-) terminals of batteries to touch any protective material directly when the batteries are kept in areas where protective materials are in use.

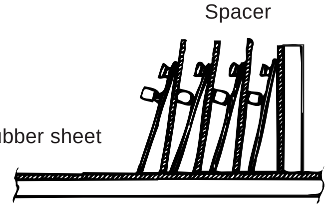
Examples of actual problematic situations:

A terminal-mounted battery was inserted into a conductive mat. The battery charge was exhaused in several days.

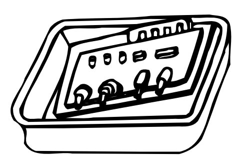


Conductive mat

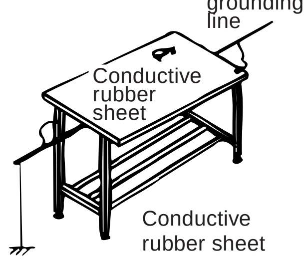
Battery-mounted PC boards were inadvertently brought into contact with spacers and a conductive rubber sheet. The battery charge was exhausted.



A battery-mounted PC board was inadvertently brought into contact with a conductive resin case. The battery charge was exhausted.


Conductive resin case

A battery was placed directly on a rubber sheet spread over a worktable. The (+) and (-) terminals were in contact with the sheet and the battery charge was exhausted.



Use caution in allowing batteries to contact each other

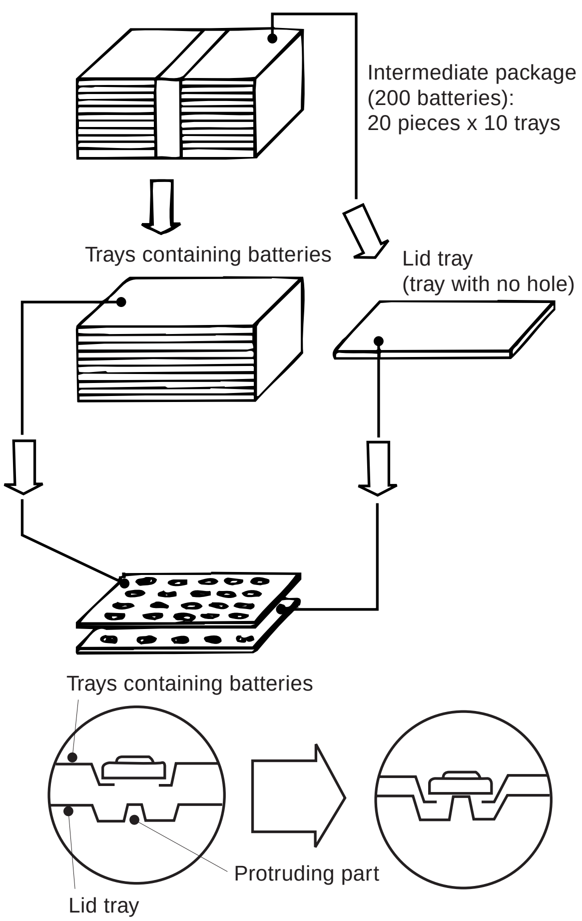
Problems have been reported where batteries with memory backup terminals or coin type batteries came into contact with each other, thus discharge circuits were formed (short state), resulting in voltage drop and capacity deterioration of the batteries.

(1) Remove batteries from the tray one at a time.
If batteries are released by turning over the tray, they will come in contact with each other, forming discharge circuits.

(2) Do not throw batteries randomly into a container like a parts box.
Discharge circuits will be formed; batteries in contact will be drained.

Recommended Procedures

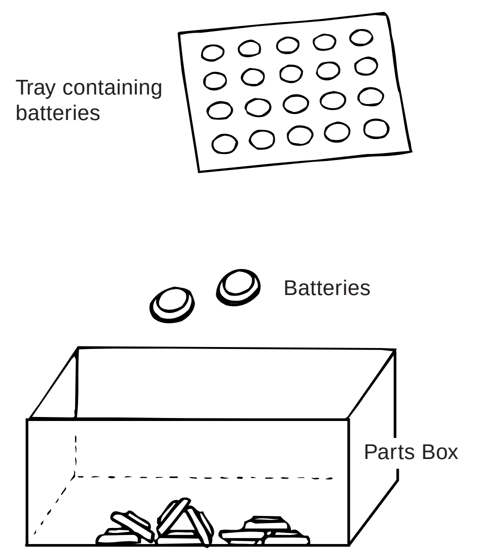
* Utilize the tray lid in taking out batteries

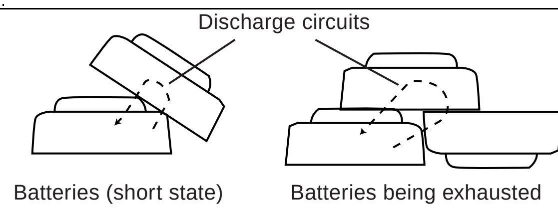


* Lay a tray lid flat and place a tray containing batteries on top of it: batteries are pushed up by protrusions of the lid tray so that they can be easily picked up with fingers.

Prohibited Procedures

* Do not throw batteries randomly into a parts box by turning over trays containing batteries.





* Contact of batteries with each other forms discharge circuits, thus the batteries are drained.

Use caution in setting charge voltage

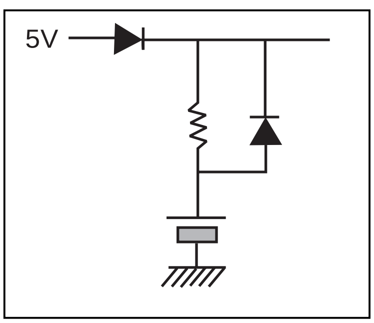
Observe the following precautions for **SAFE** use of vanadium lithium secondary batteries.

1. Charge voltage range

- In fixed-voltage charging, observe the specified charge voltage value.
  Specified value (guarantee value) in the range of -20°C to 60°C is 3.4±0.15 V (effective value is 3.4±0.20 V).
  * If the charge voltage exceeds the upper limit of the specified range, internal resistance of batteries may increase, causing deterioration of batteries. Also, with a charge voltage around 4 V, corrosion of the (+) terminal (case) may occur, causing leakage (see next page).
  * If the charge voltage is below the lower limit of the specified range, complete recovery of the battery capacity becomes infeasible.
- In fixed-current charging, observe the specified charge current with circuit design so as not to allow the battery voltage to exceed the above-described upper limit of the specified voltage range.

2. Trickle charging

- Do not use trickle charging (illustrated below) which is applied to nickel cadmium batteries, as this will allow VL battery voltage to rise to about 5 V, causing deterioration of the batteries.



3. Use in series

- When using two or more batteries in series, be sure to contact us.

4. Inversed connection of (+) and (-) terminals to devices

- The (-) terminal (gasket) may be corroded, causing leakage.

5. Mixed use

- Avoid mixed use of VL rechargeable batteries and lithium primary batteries or other secondary batteries. Also, avoid mixed use of new and old batteries even if they belong to the same series. The mixed use of batteries may cause battery deterioration causing damage to devices due to differences in voltage and capacity of batteries.

6. Soldering

- Do not apply solder directly to batteries, as this will heat batteries, thus causing damage to resin materials such as gasket and separator, and lead to leakage or battery rupture. Usual automatic dip-soldering is applicable, but do not use reflow soldering.

7. Others

- Do not throw into fire, heat to 100°C or higher, or disassemble the batteries, as this will pose a danger.

INFLUENCE OF CHARGE VOLTAGE OF VANADIUM PENTOXIDE LITHIUM RECHARGEABLE BATTERIES